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Nation's S&T Information Work Outlined

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[Article by Liu Zhicai [0491 1807 2088] of the China S&T Information Institute: "A Brief Introduction to S&T Information Work in China"]

[Text] S&T information work in China mainly includes four areas:

1. Document work. S&T information is mainly deposited in S&T documents. Information workers broadly collect S&T documents from China and foreign countries, process and organize them, establish databases, compile card records and books of periodical searches, and provide various document services. China's S&T information system now has hundreds of millions of Chinese and foreign periodicals, Chinese and foreign scholarly conference records, Chinese and foreign reference books, government S&T reports, patents, and standards from all countries, and so on. The documents are in the form of books, microfilm, magnetic tape, laser disks, and so on.

2. Computer search services. China's S&T information system has been connected with international on-line search systems and users can make communications connections with nine international on-line search systems via more than 100 remote terminals established throughout China to search S&T information from all countries of the world. They can also obtain the newest international market conditions and news reports, and they can consult various types of databases in several units in China.

3. Information research work. Information survey research undertaken by the China S&T Information Institute provides research reports for decision making by leadership departments at all levels and provides users with technical discussions, product development, and other information and consulting services.

4. Technical information services. We provide enterprises with technical information and new product information and organize various types of technical exchange and exhibition service activities. Examples include the China S&T Information Institute's establishment of the China S&T Achievement Database, Chinese Enterprises, Companies, and Products Database, and others. With support from the United Nations Development and Planning Office, we established the Technical Information Promotion System and can also enable users in China to enter the international information market and provide a large amount of technical and economic information to the United Nations Industrial Development Organization's Industrial and Technical Information Repository, the European Community's Commercial Cooperation Center, the Asia-Pacific Technology Transfer Center, and other international technical and trade information organizations. China's S&T information work began in 1956 and has now attained a preliminary scale after more than 30 years of development. We now have more than 500 professional information organizations at the prefecture and city level and above that are under the jurisdiction of the State Science and Technology Commission, National Defense Science, Technology, and Industry Commission, Chinese Academy of Sciences, institutions of higher education, libraries, and several other ministries and commissions and are located throughout China. Most provincial and municipal level information institutes have achieved international and domestic on-line searching. Users can easily consult all types of S&T information.

Status of Industrial S&T Progress Reported

92FE0580A Shanghai WEN HUI BAO in Chinese 8 May 92 p 6

[Article by Yu Hongsheng [6735 7703 0524]: "Accelerating S&T Progress Is an Urgent Task for Enterprise Development"]

[Text] Abstract: Today, when S&T has become the first force of production, what is the situation of S&T progress in China's enterprises? This article uses full and accurate data and materials to alert us that the S&T progress situation in China's enterprises lags far behind the developed countries and that we cannot be optimistic about the role that S&T progress is playing in developing forces of production in enterprises. For this reason, the author suggests that we should use intensive reform and import market mechanisms to readjust the structure of S&T resources and slant them toward enterprises, form inherent mechanisms for enterprises to pursue S&T progress, and change the "bottleneck effect" in converting S&T achievements into forces of production. Fill out enterprise S&T staffs and turn them into a regular army for S&T circles and use this to accelerate the pace of S&T progress in enterprises.

Science and technology are increasingly becoming the most important support force in modern forces of production. To gain a position in world competition of overall national strengths, China's large and medium-sized enterprises are facing an urgent task in relying on S&T progress to develop forces of production.

I. A Glimpse of the Current Situation for S&T Progress in China's Enterprises

The connotation of enterprise S&T progress is improvement of existing modes of production, which mainly includes upgrading production equipment, technology, and existing materials, designing new products, technical integration, importing entirely new technologies, and so on. S&T is the hope of China's economy and China's enterprises, but the present situation is troubling.

Ultimately, S&T progress is progress in the cultural qualities of people, but the cultural qualities of the labor force in China's enterprises is dominated by physical

labor on the foundation of a "binary" structure. Calculated using a "comprehensive index of cultural qualities", the indices for categories of China's labor force in 1982 were physical labor 62.58 percent, cultural 36.55 percent, and S&T only 0.87 percent.

The hardware and technical equipment for China's S&T progress is "second generation" forces of production, meaning mechanical forces of production. At present, China's state-run enterprises have 1.29 trillion yuan in fixed assets that have a net value of about 900 billion yuan. According to a World Bank survey, 20 percent has the level of 1960's and 1970's, 20 to 25 percent is outdated but can still be used, and 55 to 60 percent should be discarded. A survey of equipment in 517 large and medium-sized enterprises throughout China showed that only 12.7 percent attained international levels. Among the enterprise equipment, just 2.6 percent had automated operation, 24.85 percent was mechanized, 33.7 percent was semi-mechanized, and 28.85 percent was manually operated.

The technological structure of China's enterprises basically is a two- generation technical system. S&T progress is the carrier and support for production measures and laborers. The technological structure is the mode of expression of S&T progress and is also the dominant force in the industrial structure. In China's enterprise technological system, there are lasers, space, nuclear power, and many other world-class incisive automated technologies as well as manual and semi-mechanized backward technologies, with the two forming an enormous contrast.

China's technology imports have always remained in a situation of dominance by complete sets of hardware equipment. During the 30-year period from 1950 to 1979, complete equipment sets accounted for 93 percent of our total volume of imports and the industries were concentrated mainly in the energy resources, raw materials, chemical, and other basic industries. Statistics show that 70 percent of technology development in enterprises in recent years has depended on technology imports. A survey of 2,300 imported technologies by the State Science and Technology Commission showed that only 9.2 percent of imported items at present have been digested and absorbed to different degrees. China's large and medium-sized enterprises invested 8.11 billion yuan on technology imports during 1988, but only 9.1 percent was invested in importing designs, blueprints, techniques, and patents. This shows that the technology absorption and redevelopment situation in China's enterprises is far from ideal.

Among the multitude of routes that large and medium-sized enterprises use to achieve S&T progress, technical upgrading should be hold the primary position. This is not the case in reality, however. From 1985 to 1988, investments in new construction and expansion as a proportion of total investments rose from 48.4 percent to 51.7 percent, while technical upgrading declined from 42.7 percent to 40.7 percent over the same period. Behind the 22 percent annual increase in technical upgrading in China's enterprises lies concealed the problem of using of the name technical upgrading that actually involves new construction and expansion. Two-thirds of investments in technical upgrading go to expand production capacity and only about 20 percent is used for energy conservation, reducing consumption, and improving the product mix.

S&T progress in enterprises is embodied mainly in developing markets and improving product quality. The superior quality product rate for China's industrial products, however, is just 10 percent. A survey of 26,000 products in China's machine-building and electronics industry showed that only 3 percent attained levels of the 1970's. There is a 48 percent shortage of product varieties in China's markets.

Production in China's enterprises involves inputs for consumption of non- technology resources. The amount of standard coal consumed to produce $100 million in value of output is about 210,000 tons in China, which is 2.3 times the amount in the United States and 5.6 times the amount in Japan. In the area of raw materials utilization, China's utilization rates are 50 percent for lumber and 60 percent for steel, but the developed nations have attained 95 percent and 85 percent.

We cannot be optimistic about S&T progress in large and medium-sized enterprises. This point has attracted the attention of economic circles, S&T circles, and enterprise circles.

II. Trends of Change of S&T Progress in Enterprise Forces of Production

Several trends have appeared in recent years in regard to the impact of S&T progress on forces of production in China's large and medium-sized enterprises.

There has been a trend toward a growing contrast between increases in value of output and falling profits and a substantial increase in actual total product costs. Substantial price increases in recent years for energy resources, minerals, raw materials, and other elementary products and for metal smelting, chemical industry, construction materials, and other intermediate products have made it hard for ultimate product production departments to digest production costs, and they have been forced to readjust prices to continue maintaining their economic speed. This has resulted in repeated product price increases in all categories of production and constituted a significant contrast between increasing value of output and declining profits. Statistics show that in several huge enterprises, the gross value of industrial output grew by 18 percent from 1980 to 1985 while profits and taxes grew at a rate of less than 1 percent and production costs rose at an annual rate of 12 percent.

The marginal value of output of fixed assets has declined and the profit rate on investments has shown a tendency toward declining. Marginal value of output of fixed assets refers to the proportional relationship between the

last addition of a specific amount of capital input to the ultimate increase in output. The rate of economic growth in large and medium-sized resulting from capital construction, expansion, and new construction inputs has become increasingly slower. If it can be said that during the 1970's there was flourishing momentum in marginal value of output from inputs of fixed assets in several large and medium-sized enterprises, then after then mid-1980's, system and mechanism defects led many enterprises to focus on quantity and neglect quality, to focus on speed and neglect results, and to focus on inputs and neglect output. Estimates indicate that the marginal value of output in enterprises in the petrochemical industry, a big profit-maker in China, has fallen most years, which has resulted in a sharp decline in the profit rate for investments.

The elasticity coefficient for enterprise forces of production has shrunk and returns to scale have tended to decline each year. Fixed assets and labor power inputs constitute returns to scale for enterprise results and the proportional increase between the two for enterprise output constitute the elasticity of forces of production. Measurement of returns to scale in several of China's large and medium-sized enterprises show that during the last half of the 1980's they declined during most years and the elasticity coefficient of forces of production has gradually shrunken.

The contribution rate of S&T progress in enterprises is rather low and has shown a trend toward gradual reduction. The contribution rate of S&T progress is an important indicator used to assess S&T progress in China's enterprises. Today's development of high S&T have raised science and technology up to the decisive status of the first force of production. Calculations by the World Bank show that in the developed countries now the contribution rate of S&T progress has reached 60 to 80 percent, but is only 40 percent in China.

The contribution rate of increased productivity of all factors of production has been in a state of fluctuation and stagnation for more than 20 years. Analysis of economic growth factors indicates that increased inputs of factors and increased productivity are the two most fundamental factors behind economic growth. The quality of economic growth is determined by the degree of increased productivity that is contained within it and by the size of the component of its contribution to economic growth. Increased productivity and economic growth in China form several unique change situations. One is that it lags behind economic growth. The rate of increased productivity has always lagged behind the rate of economic growth. Trends of change in rates of increase in labor productivity and capital productivity compared to the rate of economic growth show that not only did they not shrink between 1979 and 1988, but instead tended to expand. Second is a situation of a low-quality sustained high rate of growth. The contribution rate of increases in labor productivity is low and the contribution rate of increases in capital productivity is also next to nothing. Increased national income has depended entirely on increases in the amount of capital inputs. This means that China's sustained high growth rate has to a very great extent been propelled by inputs of large amounts of capital.

III. Countermeasures To Promote Enterprise S&T Progress

Rational readjustment of the S&T resource structure. China's research and development is concentrated primarily in scientific research organizations in government departments, which account for 59.84 percent of existing total statistical expenditures and 53.49 percent of S&T personnel. On the other hand, large and medium-sized enterprises only account for 37.99 percent of total expenditures and 35.29 percent of S&T personnel. Very few enterprises have specialized research institutes, which has greatly restricted S&T progress. In contrast, 90 percent of the scientific research personnel in several developed nations are concentrated in enterprises and only 10 percent of research organizations are independent and outside of enterprises. Statistics show that administrative institutions account for 68.2 percent of China's S&T manpower resources while those that are truly on the front line of production account for just 31.8 percent. In a survey of 10,738 large and medium-sized enterprises, engineering and technical personnel accounted for 5.99 percent of the total number of employees and S&T personnel involved in technology development accounted for only 3 percent of the total. For this reason, S&T personnel, who are the primary carriers of S&T knowledge, should be increased in proportion on the first line of production. Only in this way can we fully foster the role of S&T as forces of production.

Enterprises should form inherent demand mechanisms for S&T progress. Enterprises are the economic train that converts science and technology into forces of production and the enterprise station from the administrative perspective looks closely at each S&T invention and innovation. At the same time, it also occupies a central status in strategic decision-making for research and development. However, because China's enterprises are subject to system and mechanism restrictions, they commonly ignore this responsibility, which has resulted in inadequate production reserve strengths. For this reason, we must make "enterprise product market cornering rates", "S&T progress rates", and other indices that play a role in S&T progress the actual content for examining the administrative achievements of enterprises.

Transform the "bottleneck" effect in conversion of S&T into forces of production. Moving from S&T to forces of production requires a process of conversion that involves basic research, applied research, technology development, intermediate testing, fixed-model production, and so on. Generally speaking, basic, applied, and some development research are completed by independent scientific research organizations, while enterprises concentrate on technology and economic extension and can derive economic benefits. There is no way, however,

for S&T circles and enterprise circles to take on intermediate testing and fixed-model production, so they become a "bottleneck" in converting S&T into forces of production. The reason for its formation is that S&T departments are restricted by manpower, materials, and capital. The experience in developed countries is that the ratio of the investments required from basic research to technology development and on to large-scale industrialized production is 1:10:100. This obviously would be hard for China to achieve. Thus, S&T achievements can only remain in the "sample, exhibit, and gift" stage. Statistics indicate that technology development expenditures in the metallurgy, chemical, machinery, electronics, and other industries in China account for 0.5 percent, 1.1 percent, 1 percent, and 5.5 percent, respectively, of their gross value of output. The average levels for the same industries in foreign countries, however, are 1.5 percent, 3.3 percent, 4.5 percent, and 10 percent. Thus, improvement of the S&T market has become the key to promoting S&T progress in enterprises.

In promoting S&T progress, besides changing the coarse expanded reproduction that consumes large amounts of resources and taking the route of exploiting potential, upgrading, and intensive-type intensional expanded reproduction, enterprises should determine the development goals and models for S&T progress on the basis of their own technical capabilities, circumstances, and market position. The more distant and larger the development objectives of enterprises, the greater is their motive force for S&T progress and the greater is the depth and breadth of S&T progress. Looking inward, using product innovation as the dominant force, perfecting a systematic and scientific S&T organizational framework, using capital inputs as a turning point, achieving a "collection of treasures" of technology, encouraging fair competition, weakening the consciousness of government "protection", and embodying the value of S&T as forces of production in market competition are important ways to improve S&T management mechanisms in enterprises.

S&T forces in China's large and medium-sized enterprises are the main army in developing applied technology and converting S&T achievements into forces of production. Enterprises should stand at the leading edge of market competition and use their own existence and development requirements, keenly seize the newest achievements in international S&T, and painstakingly and quickly create new modes of production to promote the development of S&T progress in society. Thus, achieving urgent needs requires accelerating the establishment of the status of S&T forces in large and medium-sized enterprises in China's S&T work, using appropriate policies to promote and foster initiative in enterprises, and viewing them as a regular army in China's S&T system. This should be a national policy for promoting S&T progress in China's enterprises.

Status of Functional and Electronic Material Developments in China

92FE0540A Beijing XIANDAIHUA [MODERNIZATION] in Chinese Vol 14 No 3, Mar 92; Vol 14 No 4, Apr 92

[Article in two installments by Wang Run [3769 3387] and Zhou Shouzeng [0719 1108 1073]: "A Review and Discussion of the Current Status of Functional Material Development in China"]

[Mar 92, pp 26-28]

[Excerpt] [Passage omitted]

3. Current Production Status and Gaps in China

China has achieved encouraging success since the beginning of the development of functional materials; however, present development still cannot be fully adapted to the following five areas:

(1) Our production cannot meet the demand of our current industrial output. China has imported more than 200 production lines of instruments, and electronic production systems, yet we depend heavily upon imports for functional materials. For instance, the local production of cold-rolled silicon wafers supplies only 10 percent of the national demand, and the import of magnetic head material amounts to 150 to 200 tons.

The insufficient supply of local functional materials results from China's outdated production equipment and backward technology, non-coordinated production equipment sets, and low capacity. The tape coils we manufactured are small, heavy, narrow, inconsistent in dimension controls, poor in surface qualities, and non-uniform. The resolution of these problems depends on the improvement of equipment, technologies, and management.

(2) Current production does not meet the need of international markets. China has 80 percent of the world's rare earth reserves, but the production of the rare earth permanent magnets amounts to only 5-6 percent of the world's production. China's current production capacity of NdFeB permanent magnet is about 200 tons. The NdFeB magnet demand in the Western world is projected to be 10,000 tons in the year 2000. If we were to produce one-fifth of the global demand of NdFeB, our yearly production capacity should be about 1,000 to 2,000 tons. At present, the gap between the actual and ideal amount of production is quite wide. In 1986, the global market required 4,700 tons of single crystal silicon; we produced only 50 tons in 1985. The global market demanded about 20 tons of single crystal gallium arsenide in 1987 while our production was only 100-200 kilograms. Consequently, we have no position in the world market.

(3) Componentization of functional material is inadequate in China. In the last decade, the world market moved toward functional material componentization—

to integrate the functional components production with functional material production. Componentization could advantageously associate production with utilization. The products will be of higher output value, and easier to market. For example, the soft magnetic functional material can be made into inductance components (such as transformers, coils, and choke coils, etc.). In 1988, we manufactured 350 million units of inductance components; in 1986, Taiwan produced 2.1 billion units of inductance components, a major portion of which was exported. In 1988 South Korea produced $360 million worth of inductance components, one-third of which were exported. There is great export potential for our functional material components in the global market.

(4) China is not meeting the challenge of modern technological revolution. China conducts more traditional material research than new functional material research; moreover, research in China is more imitative than creative. For instance, we are a rare earth rich country, yet all three generations of permanent magnetic materials were developed outside China.

(5) Present development does not fit in the long-range plan. Our functional material research projects are all short-range projects, weak in basic research and lacking exploratory efforts. Laboratory work on certain new materials are not very systematic or in depth. These factors affect product diversity and quality.

[Apr 92, pp 18-19]

[Text]

China Should Assign Priority to the Development of Functional Materials and Their Technologies

In view of the international trend and the demand of our scientific and technological development from 1990-2000, and for the purpose of building a foundation for our new products in the 21st Century, the following areas of functional materials and their technology should be prioritized in the near-and medium-term development:

1. Intermetallic Compound Functional Material

According to incomplete statistics, most of the newly developed functional materials are compound materials, such as super-strength rare earth compound permanent magnetic material, super magnetostriction material, hydrogen-storage material, shape-memory material, superconductive material, semiconductive material, luminescent material, magnetocooling material, etc. The development of intermetallic-compound functional material has been the most active area in the new material field in recent 20 years. Their introduction heavily impacted the traditional metallic materials. It is predicted that they will develop even faster in the next 20 years. There are thousands of different types of intermetallic compounds, but less than 1 percent of them have been utilized. Each of the intermetallic compounds has its specific fixed molecular composition, particular electronic structure and energy band structure. The compounds possess strong bonding force, high strength, and high stability, as well as other unique properties such as invar effect, elinvar effect, magneto-optical effect, and magnetoresistance effect. Developed countries consider functional materials from intermetallic compounds to be the key in material development. In this field, China should concentrate on the following research subject:

(1) *New Generation Rare Earth-Compound Permanent Magnet Material:* These materials should possess highly saturated magnetization intensity, high magneto-crystalline anisotropy, and high Curie point. Their raw materials are abundant, and their production technique is simple. They can replace the ferrite magnetic material in great amounts.

(2) *Super Magnetostriction Materials:* The significant magnetostriction property of ferro-rare earth material is that its length, sonic speed, and Young's modulus change with the change of magnetic field. The change of magnetic field produces internal stress in the material. This property becomes the physical basis for high technology products and has the prospect of extensive application in precision dimension control, delay line, sonar technology, supersonic technology, and weaponry. China should emphasize research on the materials' compositions and structures, as well as the correlation between their metallurgical factors and their properties.

(3) *Magnetic Cooling Material:* There is a temperature change in a ferro- or para-magnetic material during the process of magnetizing or de-magnetizing. This effect can be utilized to create low temperature. Magnetic cooling or refrigeration has drawn great interests because the process is efficient, compact, and highly dependable. The most effective magnetic cooling materials best identified today are the rare earth compounds. Using $RAl_{2.2}$, the magneto-cryogenic machine can reach a temperature of 20-77°K. The magneto-cooling materials for application at room temperature are now being researched in the United States, France, and Japan.

(4) *Other Compound Functional Material:* Such as semiconducting material (GaAs, etc.), luminous material, and hydrogen-storage material.

2. Non-Equilibrium Functional Materials

Non-equilibrium materials include non-crystalline materials, ion implantation materials, chemical diffusion materials, and other materials made under special conditions (e.g., ultra-high pressure). They present brand new realms of material study. These materials are superior to traditional ones for their super-high magnetic conductivity, ultra-low transmission loss, super-high strength and super plasticity, super erosion resistance, etc. They have been applied for industrial use. We should prioritize our research as follows:

(1) *Non-crystalline sensing functional materials:* Materials which react sensitively to pressure, heat, magnetic field, light and electricity, etc.

(2) *Ion implanting materials.*

(3) *Gradient materials:* These are materials of macroscopically non-uniform and gradient-changing compositions, structures, densities, and properties or functions. For example, the wall of a cylinder or combustion chamber has an inner surface of ceramics (for its hardness) and an outer surface of metal (for its good thermal conductivity and strength), but there is no boundary between these two materials. The absence of a boundary is achieved by continuously changing the composition, structure and density of these two materials. Thus no internal stress is generated. This type of material is called a gradient material. They can effectively combine metals, inorganic non-metals, and high molecular materials into one special-purpose high-efficiency material. Functionally gradient materials are a new direction for development in the 21st Century. They will be widely used in bioengineering, nuclear engineering, oceanographic engineering, instrumentation and electronic technology.

(4) *Nanometer (nm) Polycrystalline Materials:* Nanometer polycrystalline materials are consolidated by cold pressing (cold sintering) crystals of sizes in the nm range (1-10 nm). Their structures (the volume ratio of non-crystalline and crystallines is about 50 percent), specific heats, densities, and coefficients of thermal expansion are different from those of three-dimensional crystalline and non-crystalline. They are brand-new materials.

3. Low-Dimension Functional Materials

Low-dimension functional materials have been widely used in high-tech fields, and have become one of the developmental directions. The following are several focal areas of development:

(1) *Zero-Dimension Materials:* Zero-dimension materials are the ultra-fine particles with dimensions between 0-100 Angstroms. The ultra-fine particles are also called the fourth state materials. The other three states (solid, liquid, and gas) materials have been well studied, but the fourth state material is insufficiently understood. It has a series of special functional properties. When the ultra-fine particles are used in sound recording, the recording density can be increased by ten fold; as a fuel, the combustion efficiency can be increased by 100 times; as a catalyst, the catalytic efficiency can be increased by 100 times. These materials have the prospect of wide application in the following technological areas: catalysts, pharmaceutics, filtration, electrode, stealth, combustion, sensors, heat exchange, instrumentation, composite materials, and information storage. Research on ultra-fine particles should be conducted on their structures, properties, production equipment and technology, storage and transportation, as well as their applications.

(2) *One-Dimensional Materials:* One-dimensional materials are ultra-fine fibers including reinforcement fibers and functional fibrous materials, etc. Research should be conducted on the structures and properties of fibrous materials.

(3) *Two-Dimensional Materials:* Two-dimensional materials are thin-film materials which have been widely used and will become the physical foundation of high-tech in the 21st Century. The advantages are that thin-film technology could make devices thinner, lighter, and more integrated. We should research magnetic thin film materials, electric resistance thin films materials, superconductive thin films materials, and sensor thin films materials, etc. We should also study different multi-function high-polymer thin films, such as separation film, electrodialysis film, diffusion film, millipore filtration film, gas separation film, etc.

4. Composite Functional Materials

Composite functional material development is a brand new field of study. Composite functional materials include solid state three-dimensional composite materials (e.g., thermal bi-metal, electric contact composite material, multi-layer composite magnetic cooling material, etc.), solid state multi-layer composite thin-film materials, mixture of solid state powder particles and plastics or low melting point metals (e.g., bonding magnets, etc.), and mixture of solid particles and liquids (e.g., magnetic liquid), etc. It is suggested that the following areas be studied:

(1) *Mixtures of Solid Magnetic Powders and High-Molecule Materials or Low Melting Point Metals—Bonded Permanent Magnet Material:* This type of material has a broad development future and has been widely used in electrical and electronic technology, instrumentation technology, home electrical appliances, and office equipment, etc. Our study of the bond magnet is still in the starting stage. Future research should emphasize the rare earth bonding magnetic materials.

(2) *Mixtures of Solid Magnet Powder Particles and Liquids—Magnetic Liquid:* Magnetic liquid is a very stable colloidal mixture of strong magnetic powders (about 100 Angstroms in size) dispersed in liquid. This liquid has super-paramagnetic property and viscosity, and low anisotropic property. Magnetization by the magnetic fields will affect its fluidity. It possesses good sealing and damping properties. This material can be used in the fields of magnetic printing, magnetic damping, magnetic sealing, magnetic separation, medical technology and astronautic technology.

(3) *Solid State Multi-Layer Composite Thin Film Material:* Other countries are now studying a series of multi-layer thin-film composite materials with alternative layers of 3d-3d and 3d-4f metals. The thickness of each different layer varies from a few Angstroms to several tens of Angstroms. There are three types of the multi-alternative layer composite films: non-crystalline, micro-crystalline, and crystalline. They have a series of functional properties and will be efficient materials in the 21st Century.

5. Functional Artificial Crystalline Materials

The artificial crystalline material becomes more important in the following high-tech fields: laser, infrared, communications, information technology, microelectronics technology and photo-electronic technology. Today, in the field of electronic technology, microelectronic is moving toward photoelectronic, and the importance of the functional artificial crystalline materials becomes more obvious. We have a quite early start in artificial crystalline material research, and established a good foundation. We are only slightly ahead in the field of inorganic non-linear optical material. The developed countries have stepped up their efforts in the research of functional artificial crystalline materials in the last decade. The United States has proposed a plan investing 20-50 million dollars in the research of artificial non-linear optical materials. Both Japan and the former Federal Republic of Germany are also strengthening their research of this type of material. China should make the research of artificial crystalline material an objective of new material development:

(1) *Strengthening research of laser materials:* Resolving the problems of size, higher optical quality of the Nd:YAG crystal growing technique should be emphasized. In addition, the composite functional laser materials should be further developed so that the crystalline materials such as Mg:LN, Mg:Nd:LN, NYAB, etc. could be put into practical application. In order to increase laser efficiency, laser materials with a wave length of 1.54 micron or longer should be explored.

(2) *Emphasizing research of non-linear optical crystalline materials:* Research of the physical effects of non-linear optical crystalline materials should be stressed. The research of non-linear optical materials should be linked with the study of semi-conductive materials.

(3) *Developing the optical reflection crystal materials:* The functions and properties of KTN crystal, BGO, BSO nonferrous conductive oxides and semiconductive crystals GaAs, InP, CdTe, etc. in the area of optical reflection should be studied.

(4) *Studying other artificial crystalline functional materials:* For example, crystalline materials of BSO, $ZnWO_4$, CsI and TG which are used to inspect and measure wave bands in the range between gamma ray and infrared should be studied.

(5) *Developing the science and technology of artificial crystalline functional materials:* Research should be in the following aspects: crystal growth mechanism, computer programming to simulate crystal growth, developing theory of crystal growth dynamics, as well as strengthening crystal growth equipment and its technology. New crystal growth equipment, new techniques and technologies, and the processing of artificial crystals should also be studied.

6. Human Implant Material and Intelligent Materials

According to reports, over 300 million people in the world have bone problems. It is estimated that between 40 to 50 million of them need joint replacement. For instance, in Myers Affiliated Hospital alone, from 1969 to 1977 there were 14,995 cases of joint replacements, including hip joints (about 10,000), knee, finger, elbow, shoulder, ankle, and wrist joints. Most of these implants were made of metals. The improvement of implant materials has a direct bearing on human health. Our research and manufacture of implant materials is still in the beginning stage. It is suggested that we should also devote our efforts to the research of materials such as special purpose stainless steels, titanium alloys, and high-molecules materials.

Historically, intelligent materials are considered as the fifth-generation material (i.e., stone, iron and steel, synthetic high polymers, artificially designed material, and intelligent material). Its distinctive characteristics are that its properties change with the environmental change of time and space. It can be soft or hard, rigid or ductile. Through self-adjustment, self-diagnosis, and self-recovery it is always compatible with its environment. This material is manufactured under an entirely new concept. The research of this type of material requires the interdisciplinary knowledge of material science, electronics, computing science, life sciences and bionics. Intelligent material is only a general concept now. A long period of research is expected.

7. New Material Engineering and Technology

The research of new materials engineering and technology is crucial to the development of new types of functional materials. The suggested research fields are listed as follows: 1) Low-dimension material engineering and technology, including ultra-fine particle material technology, thin-film material engineering; 2) rapid solidification technology and engineering. At present, in addition to the research of rapid solidified film tapes and powders, many countries are developing rapid solidified material and rapid cooled forming technology; 3) multi-element composite material engineering and technology, including solid-state consolidation, explosive consolidation, liquid-state consolidation and precision consolidation techniques; 4) micron size and atomic size precision processing technique; 5) surface property modification and improvement engineering and technology; 6) superplasticity process engineering and technology; and 7) engineering and technology for special purpose production material.

HN-5A Man-Portable Ultralow-Altitude Air Defense Missile System

92FE0516A Beijing ZHONGGUO HANGTIAN [AEROSPACE CHINA] in Chinese No 4, Apr 92 pp 26-28, 33

[Article by Zeng Qingbin [2582 1987 2430] of the Shanghai Institute of Precision Instruments: "China's HN-5A Portable Ultralow-Altitude Air Defense Missile System"]

[Text] **Abstract**

A description of the HN-5A man-portable ultralow-altitude air defense missile system is given. The system consists of the combat unit, the test equipment and the training simulator. The main features of the system are: a more powerful warhead, a seeker reticle coated with optical filter film, and a detector equipped with cooling devices. Improvements made to the system and the current development trend are also pointed out.

I. Introduction

The Chinese-built HN-5A portable ultralow-altitude air defense missile weapon system consists of the combat unit, the test equipment and the training simulator. The combat unit refers to the tube-loaded missiles, the launch mechanism and the thermal battery. The missile has an infrared guidance system, a multi-purpose warhead and trigger fusing unit, and a solid-propellant rocket propulsion system. This shoulder-launched air-defense weapon system is designed for visual operation against low-flying aircraft in a tail-chase or frontal-attack mode. Its main advantages include: ease of operation, high mobility, low cost and good performance. The weapon system has no special launch-site requirements; it can be launched from land, water or swamp, from the top of a building or mountain, and from a stationary or slow-moving (less than 20 km/hr) vehicle. The launch angle is 20°-60° from an upright position and 20°-40° from a kneeling position.

II. Main Features of the HN-5A

The HN-5A uses an infrared passive seeker unit to receive the infrared radiation from the target. Once the target is captured by the launch operator, the seeker performs automatic target tracking and homing. After the missile is launched, it operates autonomously. The seeker uses a normal-temperature lead sulfide (PbS) detector. The simple structure of this detector eliminates the cumbersome pipes and bottles required for throttle cooling; however, it can only detect the near-infrared radiation emitted by engine exhaust, but not the radiation from the aerodynamically heated aircraft skins. This limitation implies that in defense against a high-speed jet aircraft, the missile can only attack in a tail-chase mode; in defense against a helicopter or a propeller aircraft, it can operate in either the tail-chase mode or the frontal-attack mode.

To facilitate shoulder-launch operation by a foot soldier, it is necessary to minimize the weight of the missile by using simplified onboard control equipment. In the HN-5A design, single-channel rotational control and relay-type deflection-law control are used; also, a proportional guidance system is used to control the missile flight.

Compared with similar missiles built in this country and abroad, improvements in the following three areas have been made on the HN-5A.

1. More Powerful Warhead

During the fourth Mid-East war and the Vietnam war, man-portable air defense missiles carrying relatively small warheads were used. These small warheads allowed an enemy aircraft hit by the missile to still return to base, where it could be repaired and readied for combat again. To overcome this deficiency, the warhead of the HN-5A has been designed with enhanced fragmentation capability and higher explosive power while preserving its energy-focusing effect. Specifically, the warhead design uses increased volume of charge and heavier steel shell with improved fragmentation performance as well as improved structural configuration. Test results show that the total kinetic energy of the fragments and the over-pressure of the shock waves produced by this warhead are both increased significantly.

2. Seeker Reticle Coated With Optical Filter Film

The infrared seeker is affected by background interference caused by sunlight. If a seeker with no optical filter is aimed at the clouds or sun-illuminated concrete highways, trees, buildings or other ground objects, it often generates strong signals which would make combat operation impossible. Furthermore, it is necessary to impose a constraint on the subtended sun angle (nominal value of 35°, but in practice often greater than 40°), resulting in poor target detectability. Clearly, a simple and effective measure must be used to protect against background interference during combat.

To filter out the infrared energy below 1.8 microns in the solar spectrum, a germanium-treated lens is placed in front of the detector; the filtering effect can be further enhanced by coating the seeker reticle with long-wavelength optical filter film. But selection of the proper peaking wavelength is very important. A wavelength which is too short will degrade its interference-rejection capability; a wavelength which is too long will result in significant loss of usable energy and adversely affect seeker sensitivity and detection range. Based on field test results, the following optical characteristics have been chosen:

Transmissivity	T (at peaking wavelength)	= 15%
	T (greater than peaking wavelength)	≥ 80%
	T (less than peaking wavelength)	≤ 5%

The interference-rejection capability of the seeker can be enhanced by adding an optical filter film which reduces the background energy level by approximately 80 percent. Also, the constraint on the subtended sun angle is reduced by 10°, which allows the missile to engage in combat under a wider range of weather conditions.

3. Installation of Cooling Devices on the Detector

Because of the low detection capability of the PbS detector, the sensitivity threshold of the seeker unit is quite low; in particular, at high temperatures, the detection capability can be reduced by 50 percent-60 percent from its value at normal temperature. To overcome this difficulty, a semiconductor thermal-electric cooling device is installed on the detector to improve its performance. This device is structurally simple and operationally reliable; it is also small and light-weight. The temperature difference between its hot and cold ends can be as high as 25°C. With the cooling device, the signal-to-noise ratio of the detector can be increased by more than 40 percent under normal temperatures. At high temperatures, the effect of cooling is even more pronounced. During the development of this detector, the following technical problems were addressed.

(1) The optical system of the position indicator has a focal length which is smaller than the turn radius of the universal support structure; hence the center of rotation does not coincide with the focal point. As a consequence, the detector is not stationary relative to the missile, but swings with the rotor. As a result of using the semiconductor-cooled detector, the number of tail wires is increased from two to three, and the disturbance torque and the gyro drift are both increased. In order to reduce the disturbance torque, a highly reliable ultra-soft wire, with a bending life of more than 160,000 times, has been developed. Also, strict requirements are imposed on the degree of tightness of the external cover; a loose cover will allow the core wire to protrude outside and come in contact with the outer shield; a tight cover will cause hardening of the lead wire and thus increase the gyro drift. In addition, rigid specifications are established for the welding processes of the tail wires and the electrodes, the height of the weld point, the length of the connecting wires and the depth of gel injection.

(2) To meet the cooling requirement, a high d.c.-current (2A) power supply circuit is introduced in the electronic compartment; this circuit generates interference at the input of the pre-amplifier and increases the noise level which in turn reduces the cooling effect. For this reason, measures are taken in the circuit design to prevent current fluctuations; special efforts are also made to carefully design the layout of the power supply, the ground wires and the signal wires in the electronic compartment, to ground the shield of the tail wires, and to develop a new thermal battery with separate ground wires. Strict requirements are also imposed on the cooling device itself.

III. Integrated Test Vehicle

The integrated test vehicle consists of the vehicle (including the box car), the integrated test equipment and the target simulator.

The vehicle is a Chinese-built all-terrain vehicle whose performance has been tested in regional warfare. The box car is designed to be explosion resistant and to suppress noise transmission. The explosion-resistant walls and the box car are designed based on data from three explosion tests; the test results show that they can provide effective protection for personnel in the operating room against shock waves, fragments and noise generated by the explosion. The box car provides good electric shielding and grounding; its design has incorporated measures to prevent the generation of static electricity and to allow timely discharge. The small and light-weight diesel engine provides highly mobile operation of the test vehicle. The air-conditioning unit controls the surrounding temperature of the operating room.

The test instrument consists of the PMOS circuit, the sealed relay, the integrated operational amplifier, the transistor and the digital panel; it can operate in either an automatic mode or manual mode with digital display and automatic print-out capability.

The target simulator consists of a rotating platform on which the light source is located, and an operating platform which contains the long-focal-length parallel light pipe, the black body, the aperture conversion mechanism and the electrical control unit. The simulator has a compact structure and a reliable optical system. The rotating platform uses both position and velocity feedback systems; the position feedback system is designed to control the zero setting and position accuracy of the platform, whereas the velocity feedback system is designed to control the speed of rotation of the platform.

The time required to deploy and disassemble the integrated test vehicle is relatively short.

IV. Training Simulator

The training simulator has been developed to provide realistic and systematic training for the field commander and operator to develop a good understanding of the characteristics and operational procedure of the weapon system. In the simulator design, geometric similarity principles are used to display the flight trajectory on a 1:100-scale screen. The simulator can be used to train three launch operators simultaneously. The training missile has the same detection sensitivity and spatial filtering capability as the missile used in actual operation, but it has a design life of 200 hours. It also has a simple structure and modular design, and can operate over a wide temperature range (-40°C to +50°C). The monitoring and control system uses modern microelectronic

equipment and computerized real-time control technologies; it can print out the basic parameters and provide accurate elevation and azimuth information to the launch operator. The moving target simulator can simulate the sky background and environmental effects that would be encountered by an operator while tracking a real target.

The small test instrument used by the training simulator has three separable parts which can be carried in a canvas-covered portable case during combat. This 40-kg test equipment is one of the lightest sets used for similar missile systems built in this country or abroad. It can be used to perform tests at remote locations not accessible to the integrated test vehicle, and therefore further enhances the versatility of the HN-5A missile system.

V. Improvements and Development Trends

Like other weapons systems, the HN-5A system has certain limitations; with the development of new technologies, the following improvements can be made to the system:

1. Installation of night-vision instrument and friend-or-foe identifier (IFF)

Currently, the HN-5A can only operate during daytime; to extend its capability for nighttime operation, a night-vision instrument and an IFF unit must be installed.

2. Expanded attack zone

Because of the limitation of the PbS detector which is only sensitive in the near-infrared band, it can only track the engine exhaust in a tail-chase mode. By installing a detector sensitive in the mid-infrared band, it is possible to track the wake of the engine and detect energy generated by aerodynamic heating of the aircraft skin; this allows the attack zone to be expanded by using both the tail-chase mode and the frontal-attack mode.

3. Improvement of anti-interference capability

In recent years, many new technologies have been developed to provide the capability to guard against not only background interference and passive interference, but also active jamming by enemy aircraft. They include:

(1) Infrared imaging guidance technique, which uses a thermal image as the information source for guiding the missile and therefore is less vulnerable to jamming.

(2) Rose-shaped scanning technique, which is often used on small missiles.

(3) Dichromatic detector technique, which can detect energies in both the infrared band and the ultra-violet band; because of the large attenuation, the detector is required to have very high sensitivity.

4. Proximity detonation fusing

To enhance the effectiveness of the warhead when using a mid-infrared-band detector to track the flame from the engine, it is necessary to use proximity detonation fusing. Also, a proportional-navigation guidance law with correction term should be used to provide forward bias in guiding the missile.

Launching the HN-5A Missile in the Upright Position

The HN-5A Weapon System

The HN-5A Missile

5. Overall design improvements to the missile should be made to achieve higher speed, higher lateral load and higher reliability.

6. The size and weight of the test vehicle, the air-conditioning unit and the diesel engine should be reduced; also, their reliability and maintainability should be improved.

7. The reliability, maintainability and adaptability of the training simulator should be improved.

[Figures 1-4, four photographs showing the missile being launched, missile launch from a tank, the integrated test vehicle, and the integrated test instrument, respectively, are not reproduced. The following three photographs are reproduced from those on the inside front cover of the magazine.]

Comparison of Four Configurations for Domestic Development of Spin-Stabilized Communications Satellite

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[Article by Bao Miaoqin [0545 1181 3830] of the Chinese Academy of Space Technology (CAST), Beijing: "Comparison of Four Development Schemes for Domestic Spin-Stabilized Communications Satellites"]

[Text] **Abstract**

A comparison of four different configurations for future development of China's spin-stabilized communications satellites is presented. The comparison is based on the Dong Fang Hong-2A (DFH-2A) satellite technology and also takes into account technical approaches used by other countries in developing such satellites. It is pointed out that selection of the final configuration is primarily dictated by the development policy of future spin-stabilized communications satellites.

[Introduction]

An analysis of the potential missions and markets of communications satellites shows that as the next stage of development of China's spin-stabilized communications satellite, it is appropriate to consider a payload which carries 12 C-band transponders and has an operating life of 7 years. Based on DFH-2A technology, two different configurations can be suggested. Configuration 1 has a dual spin-stabilized and antenna-despun design, the satellite retains its short and stocky shape, but its size and weight are increased to accommodate larger payload. Configuration 2 has a gyro-stabilized and platform-despun design, and the satellite has a slender shape; it is commonly referred to as the despun-platform-type satellite.

However, the potential for future development of configuration 1 is limited because it still uses a RF-channel type rotary joint which has many technical constraints. Configuration 2 requires the development of a bearing-and-power-transfer-assembly (BAPTA) rotary joint and pendulum-type eddy-current nutational dampers which have long development cycles and involve considerable technical risks. Therefore, it is necessary to explore other configurations and at the same time gain better understanding of the problem of designing despun platform satellites.

1. Development Path of Spin-Stabilized Communications Satellites

In order to discuss the different satellite configurations to be compared, it is appropriate to first present a brief review of the development path of spin-stabilized communications satellites. Table 1 lists the technical parameters of nine representative communications satellites developed over the past 30 years; these nine can be divided into four different stages, as indicated in Table 2 and Table 3. From the applications point of view, the dual spin-stabilized configuration is actually the first stage of development of

communications satellites; the "DFH-2A" belongs in this category. Its main disadvantage is that it does not have a locked RF-channel-type rotary joint, which causes a loss of more than 1 dB in the transponder output, and limits the choice of onboard frequency band and polarization. Also, because of launch load constraints, the weight of the despun antenna and the aperture size of the parabolic antenna are limited, which makes it difficult to achieve a narrow beam and implement beam-forming technique at C-band. Another disadvantage is that the short and stocky satellite body is incompatible with the slender fairing of the launch vehicle, thereby restricting the output power of the satellite.

Table 1. Development of Spin-Stabilized Communications Satellites

	Intelsat I	Intelsat III	Anik A, HS333	Intelsat IV	Comstar	Commercial Satellite I, HS376	Leasat	Intelsat VI	Hughes, HS393***
Launch date	**1965**	**1968**	**1972**	**1971**	**1976**	**1980**	**1984**	**1989**	**(1992)**
Satellite dimensions (cm)*	Φ75 x 59	Φ142 x 104	Φ190 x 170	Φ238 x 281	Φ240 x 356	Φ216 x 673	Φ422 x 290	Φ369 x 1,183	Φ360 x 1,000
Launch weight (kg)	68	293	560	1,385	1,520	1,080	1,350**	3,720	—
Operating frequency band (GHz)	6/4	6/4	6/4	6/4	6/4	14/12	UHF, 7/8	6/4, 14/11	6/4, 14/11
Number of transponders	2	2	12	12	24	10	12	48	48-50
Design life (years)	1.5	5	7	7	7	7	10	10	10-12
Power (W)	40	134	232	480	600	900	1,200	2,200	2,250
Pointing accuracy (°)	1.5	0.6	—	0.35	0.2-0.26	0.05	0.04	0.04	—

*Refers to dimensions of the cylindrical section, including the deployed solar panels, but not the antenna.

**Refers to the launch weight for a geosynchronous orbit.

***The Hughes 393 satellite and Intelsat VI satellite use the same service compartment.

Table 2. Four Stages of Spin-Stabilized Geosynchronous Communications Satellite Development

Stage of technical development	Overall configuration	Main features	Representative satellites		
			Name	Technical characteristics	Launch date
1	Single spin-stabilized configuration	Omni-directional antenna, no despun	Intelsat I		1965
2	Dual spin-stabilized configuration	Mechanically despun antenna	Intelsat III	No automatic balance adjustment device	1968
			Anik A	With automatic balance adjustment device	1972
3	Despun platform configuration	Payload despun platform, gyro stabilization	Intelsat IV	Despun with passive nutational damping, active nutational control	1971
			Comstar		1975
4	Deployed battery array configuration	Deployed solar arrays, RF sensor	Commercial satellite	Single spring-deployed antenna	1980
			Intelsat VI	Multiple deployed antennas, integrated liquid-propellant propulsion system, large diameter	1989
			Hughes 393	Spin-axis autonomous control	(1992)

Table 3. Classification and Development Stages of Spin-Stabilized Geosynchronous Communications Satellites

Despun mode	Deployed moving parts	Mode of stabilization			
		Single spin-stabilization	Dual spin-stabilization	Gyro stabilization	
				Passive nutational damping	Despun active nutational damping
Antenna despun mode	No balance adjustment device	(Stage 1) Intelsat I	(Stage 2) Intelsat III		
	With balance adjustment device		Anik A		
Platform despun	No deployed solar arrays; antenna has no north-south degrees of freedom		Leasat	(Stage 3) Intelsat IV	Comstar
	With deployed solar arrays; antenna has north-south degrees of freedom				(Stage 4) commercial satellite, Intelsat VI, Hughes 393

To overcome the above shortcomings, a gyro-stabilized platform-despun configuration has been developed; the short and stocky satellite body is redesigned to provide a slender shape, and the nutational damper is relocated from the spinning section to the despun section to maintain stability. In addition, the problems associated with the RF-channel-type rotary joint are eliminated by replacing it with a BAPTA-type rotary joint.

The gyro-stabilized, platform-despun configuration plays an important role in the history of spin-stabilized communications satellite development. It not only eliminates the major deficiencies of the antenna-despun configuration, but also opens a new path for future technical development of spin-stabilized communications satellites. It is clear that a spin-stabilized satellite configuration that has future development potential must have a slender-body design.

2. Four Candidate Configurations for the Development of China's Spin-Stabilized Communications Satellites

In selecting candidate configurations for the development of China's spin-stabilized communications satellites, one must consider not only the future requirements of satellite communications, but also the development trend of the whole family of domestic communications satellites. Given that a service module carrying 12 C-band transponders and a payload with 7-year design life can be built, the question of whether to establish a technical base for continuing development may lead to different decisions with regard to development configurations. At present, development of China's "DFH-3" satellite with 24 transponders is already in its first stage; according to current plans, launch of the new 12-transponder spin-stabilized communications satellite will take place after the "DFH-3" is launched. Therefore, whether to increase the payload capacity of the selected configuration is an issue that deserves serious consideration. Another factor that affects the selection decision is the technical capability of the launch vehicle, particularly the size of the fairing that encloses the satellite. A large fairing will accommodate a satellite with a short and stocky body to provide sufficient power to meet communications requirements. Leasat, which is a dual spin-stabilized satellite with a diameter of 4.2 m and height of 2.9 m, was launched in 1984 from the large cargo bay of the space shuttle; it can provide approximately 1,200 W of output power. This satellite has a platform-despun configuration, as shown in Figure 1 and Ref. 1.

Analysis shows that by using an advanced solid-propellant apogee motor in conjunction with basic DFH-2A satellite technology, it is possible to design a satellite with a projected area of 5.5 m^2 and weighing 1,450 kg which can carry 12 C-band transponders (with a payload power of approximately 300 W) and provide an on-orbit operating life of 7 years. The launch vehicle for this satellite will be the "Long March-3," which can launch a payload of 1,450 kg and is equipped with two different types of extended fairings: type A and type B. Type A fairing has a usable diameter of 2.25 m and usable height of a cylindrical section of 2.7 m; type B fairing has a usable diameter of 2.72 m and a cylindrical height of 2.6 m.[2]

By comparing the required satellite dimensions against available fairing dimensions, two candidate configurations can be suggested:

(1) A gyro-stabilized satellite with a slender-body (inertia ratio less than 1) whose diameter is 2.10 m and whose height is 2.62 m; it can be enclosed in an extended type A fairing.

(2) A large dual spin-stabilized satellite with a short and stocky body (inertia ratio greater than 1) whose diameter is 2.72 m and whose height is 2.00 m; it can be enclosed in a type B fairing.

A gyro-stabilized satellite can only use the platform-despun mode because the despun section has a nutational damper. A dual spin-stabilized satellite can use either the antenna-despun mode or the platform-despun mode. In calculating the longitudinal inertia ratio of a

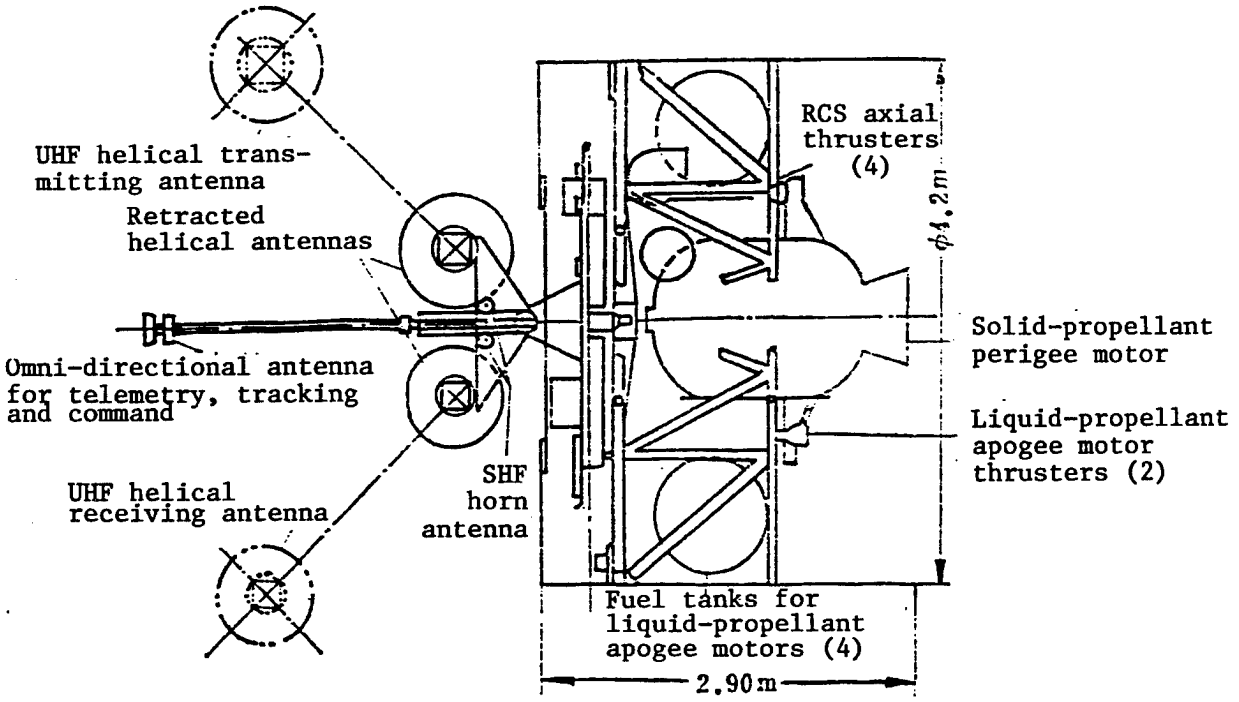


Figure 1. Layout of the Leasat Satellite

dual spin-stabilized satellite, the mass of the despun section is not included. Since the mass of the despun section is much larger for the platform-despun mode than for the antenna-despun mode, the instrument assembly should be placed as close to the despun platform as possible in order to ensure that the longitudinal-to-lateral inertia ratio is greater than 1.

Generally speaking, under the same technical conditions, when a satellite changes from the antenna-despun mode to the platform-despun mode, the overall satellite weight will increase slightly because the service module is divided into two sections: a spinning section and a despun section. If a type B fairing is used to enclose a satellite whose height is 2.00 m, then there is an approximately 0.70 m clearance for the apogee motor. If, for the purpose of reducing on-orbit weight and conserving fuel expenditure, the apogee motor is ejected after ignition, then the inertia ratio of the satellite would always be greater than 1. A summary of the four candidate configurations derived from the DFH-2A is shown in Table 4 and Table 5.

Table 4. Four Candidate Configurations

Mode of stabilization	Dual spin-stabilization		Gyro stabilization
Fairing type	Type B		Extended type A
Satellite dimensions (m)	2.72 x 2.00		2.10 x 2.62
Status of apogee motor	Not ejected	Ejected	Not ejected
Antenna-despun	Configuration 1		
Platform-despun	Configuration 2	Configuration 3	Configuration 4

Table 5. Basic Features of the Four Candidate Configurations

Comparison of configuration features		DFH-2A	Configuration			
			1	2	3	4
Overall design	Mode of stabilization	Dual spin-stabilization	Dual spin-stabilization	Dual spin-stabilization	Dual spin-stabilization	Gyro-stabilization
	Despun mode	Antenna-despun	Antenna-despun	Platform-despun	Platform-despun	Platform-despun
	Status of apogee motor	Unseparated	Unseparated	Unseparated	Separated	Unseparated
Dimensions	Diameter (m)	2.1	2.72	2.72	2.72	2.10
	Height of cylindrical section (m)	1.6	2.00	2.00	2.00	2.62
Inertia ratio	Transfer orbit	> 1	> 1	> 1	< 1	< 1
	Geosynchronous orbit	> 1	> 1	> 1	> 1	< 1
Rotary joint	Type	RF	RF	BAPTA	BAPTA	BAPTA
	Status during launch	Unlocked	Locked	Locked	Locked	Locked
Nutational damper	Transfer orbit	Passive, located on the spinning section	Passive, located on the spinning section	Passive, located on the spinning section	Active-jet nutational damping	
	Geosynchronous orbit	Passive, located on the spinning section	Passive, located on the spinning section	Passive, located on the spinning section	Passive, located on the spinning section	Passive, located on the despun section
Foreign satellites with similar design		HS333	HS399	(Leasat)		Intelsat IV

RF = radio-frequency-channel type

BAPTA = bearing-and-power-transfer-assembly type

3. Evaluation of the Four Candidate Configurations

Table 6 gives a comparison of the technical features and the advantages and disadvantages of the four candidate configurations. This provides a basis for evaluating the four configurations in terms of performance, development risk, development cycle and cost. Performance evaluation is based on the following criteria: (1) the weight and power of the payload provided by the service module under identical system hardware and overall parameters (e.g., total weight, size and operating life); (2) versatility and development potential to perform other satellite missions (such as tactical satellite, positioning satellite, etc.).

Table 6. Comparison of the Advantages and Disadvantages of the Four Candidate Configurations

Configuration	Configuration being compared	Improvements and advantages	Disadvantages and existing problems
1	DFH-2A	—Increased dimensions and enhanced payload power —Locking device added to the rotary joint, increased mass for supporting the despun antenna	—RF rotary joint limits the choice of onboard frequency-band polarization, also has more than 1 dB output loss —Lacks development potential
2	1	RF type rotary joint replaced by BAPTA type and antenna-despun design replaced by platform-despun design; reduced output loss and increased versatility in terms of multiple frequency bands and multiple polarizations	—Depends on the development of BAPTA rotary joint with 7-year operating life —No room for further improvement of output power
3	2	—Apogee motor separates after ignition, saving approximately 1/10 of fuel expenditure —Provides longitudinal-to-lateral inertia ratio larger than 1	—Active-jet nutational damper added during transfer orbit —Existing problems include maintaining proper temperature prior to apogee motor separation and reliability of separation
4	2	Short-and-stocky satellite body replaced by a slender body; dual spin-stabilization mode replaced by the gyro-stabilization mode; the configuration has good development potential	—Active-jet nutational damper added during transfer orbit —Requires Development of a pendulum-type eddy nutational damper

From the point of view of payload weight, the antenna-despun design is superior to the platform-despun design; the separated apogee motor is superior to the unseparated apogee motor; and the dual spin-stabilized mode is superior to the gyro-stabilized mode. From the point of view of payload power, the platform-despun configuration can reduce the output loss by 1.2 dB, but its solar-array panel may block the area of the heat-dissipation ring (which is approximately 200 mm in height). The smaller diameter of the gyro-stabilized satellite provides a smaller surface area of the waist-band with identical height (160 mm), resulting in an increase in the relative panel area. Table 7 gives some quantitative values for the analysis presented above.

Table 7. Payload Performance of the Four Candidate Configurations

	Configuration	4	3	2	1
Payload weight (kg)	Mode of stabilization	0	5	7	7
	Despun mode	0	0	0	9
	Separation of apogee motor	0	10	0	0
	Total	0	15	7	16
Payload power	Output loss of transponder	0	0	0	1.2 dB
	Relative panel area	0.907	0.888	0.888	0.928
	Power differential (W)	0	- 12	- 12	- 72*
Development sequence	Versatility	1	1	1	2
	Future development	1	3	2	4

*The value accounts for 1.2 dB output loss

The main factors to be considered in comparing development risks are the new technologies to be developed and the degree of difficulty involved. Table 8 lists five new technologies used by the four candidate configurations; the two technologies with the highest degree of difficulty are the BAPTA rotary joint and the pendulum-type eddy nutational damper. The locking device is relatively simple and considerable research has already been conducted. The active-jet nutational control and the techniques for temperature maintenance and separation of apogee motor during transfer orbit are based on technologies developed for the "Feng Yun 2" (FY-2) satellite.

Table 8. New Hardware Required by the Four Candidate Configurations

Configuration	1	2	3	4
Locking and releasing devices of rotary joints	Δ	Δ	Δ	Δ
Long-life BAPTA rotary joint		Δ	Δ	Δ
Active-jet nutational control			Δ	Δ
Temperature maintenance and separation of apogee motor			Δ	
Pendulum-type eddy nutational damper				Δ

The four candidate configurations have different development cycles. Configuration 1 is identical to "DFH-2A" except for the addition of a locked rotary joint; therefore, after development of the service module, it can proceed directly to the final design stage. For configurations 2 and 3, the payload, the BAPTA rotary joint and the despun platform structure must go through the stages of preliminary design and final design; however, because of the difficulty in developing the BAPTA rotary joint, their development cycles will likely be much longer than that of configuration 1. Configuration 4 is a completely new model; hence the entire satellite must go through both stages of design. If the development cycle of configuration 1 is assumed to be 4 years, then the development cycles of configurations 2 and 3 will be 5-5.5 years. If the pendulum-type eddy nutational damper does not require longer development time than the BAPTA, then the development cycle of configuration 4 will be 5.5-6 years.

The cost of development increases in ascending order from configuration 1 to configuration 4. Configuration 1 has the lowest cost because its design and hardware are essentially the same as those of the "DFH-2A" satellite. Configurations 2 and 3 require higher cost because of the development of the BAPTA. Configuration 4 has the highest cost because it not only requires the development of the pendulum-type eddy nutational damper, but also must go through two design stages.

4. Conclusion

A summary of the comparisons of the four configurations is presented in Table 9.

Table 9. Overall Comparison of the Four Candidate Configurations

Configuration		1	2	3	4
Performance	ΔG (kg)	16	7	15	0
	ΔP (W)	- 78	- 12	- 12	0
	Versatility	Poor	Good	Good	Good
	Development potential	None	None	None	Yes
Estimated risk		None	Development of BAPTA	Development of BAPTA and ABM separation	Development of BAPTA
Development cycle (years)		4	5-5.5	5-5.5	5.5-6
Development cost		Low	Medium	Medium	High
Fairing of launch vehicle		B	B	B	Extended type A

ΔG, ΔP—difference between payload weight and power; ABM—apogee motor.

The advantages of configuration 1 are: no development risk, short development cycle and low cost. But its output power is limited by the RF type rotary joint; hence this configuration is only suitable for a satellite with a single frequency band (including payload and telemetry control). Also, since its short and stocky satellite body already occupies the full extent of the type-B fairing of the "LM 3" launch vehicle, it has no further development potential.

Configuration 2 is superior to configuration 1 in terms of improved rotary joint, increased flexibility to accommodate multiple frequency bands and polarizations, and reduced output loss in the transponders; but it requires the development of the BAPTA. It would be a practical and cost-effective configuration if further development of spin-stabilized satellites is not an important consideration. Configuration 3 can accommodate a higher payload weight and ensure an inertia ratio greater than 1 because the apogee motor is separated after engine cut-off, but the reliability problem of apogee-motor separation must be solved.

The advantage of configuration 4 is that it has good development potential. Although it is capable of carrying a smaller payload than other configurations and requires the development of a pendulum-type eddy nutational damper, it is the only configuration that allows further development of spin-stabilized satellite configurations.

Based on the above discussion, the recommended configuration should be configuration 2 or configuration 4. Selection of the final configuration will depend on the decision with regard to China's future policy of developing spin-stabilized communications satellites. Specifically, the question is: after achieving the capability to build a satellite with 12 transponders and 7-year design life, should we continue our efforts to develop a 24-transponder satellite? Of course, if detailed design shows that configuration 2 cannot simultaneously meet the requirements of output power and inertia ratio because of the 2.72-m diameter constraint of the launch vehicle, then configuration 4 would become the only possible choice.

References

1. Wheelon, A. D., "The Impact of Space Shuttle on the Future Communication Satellite," Presented to the Telecommunications Association, Tokyo, Japan, 1978 (9).

2. LM-3 User's Manual, Revision 1, CGWIC, 1988.

Jiuquan Launch Center Upgrades Technology To Enter World Market

92FE0580C Lanzhou GANSU RIBAO in Chinese 4 May 92 p 3

[Article by Zhou Shiyu [0719 0013 0151] and Wang Hongxi [3769 4767 0823]: "Jiuquan Launch Center Reinforces Technical Quality, Adapts to the Need for Space Technology To Enter the International Market"]

[Text] In the new situation of reform and opening up, Jiuquan Satellite Launch Center is adhering to and implementing the principle of the Central Military Commission to focus on quality in military construction, further improve military experiment capabilities, adapt to the needs of China's space technology for moving into the international market, and accelerating technology quality construction in the military.

This center is the earliest and largest-scale missile and satellite launch experiment base area China established. It has successfully completed launch experiment tasks for over 20 satellites and nearly 1,000 missiles and rockets. Reviewing the achievements

made, one of the extremely important factors is that it has focused on military technology quality construction. As China's national defense incisive technology has developed at a flying pace and space technology has continually moved into the international market, the center has assumed responsibility for ever-growing numbers of large-scale experiments and the launch and lifting tasks it has taken on are constantly increasing. To ensure satisfactory completion of all types of experiment tasks, this center placed reinforcement of technical quality construction in an important status in 1992 and formulated concrete implementation measures. One is gradual perfection of the S&T cadre system, improvement of the military knowledge structure, straightening out the relationships among "entering, leaving, promotion, and training", and other links, doing good organizing of technical cadre upgrading and knowledge renewal, and achieving a shift in its technical staff from an operational type to an experimental project type. Second, it has adhered to the principle of "CPC Committee discussion and training, persons in charge pitching in to work, chief instructors going into action, joint efforts by organizations" and used the "Military Training Regulations" as a foundation for training in the law. Third, it has carried out updating and technical upgrading of existing equipment and facilities in a planned manner, reinforced basic research and scientific research innovation, focused on experimental projects and construction projects, and improved experiment measures and economic benefits.

105-mm-Diameter Float-Zone Silicon Monocrystal Batch Produced

92P60341A Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 3 Jun 92 p 2

[Article by Cheng Xiaoshuang [4453 1420 3642]: "Nation's Ability To Manufacture Large-Diameter Zone-Melt Silicon Monocrystal Rises to New Height"]

[Summary] With its ability to stably batch produce high-quality 3-inch large-diameter zone-melt (i.e. float-zone) Si monocrystal firmly established, the Beijing General Institute of Nonferrous Metals recently succeeded in perfecting 105-mm [4.13-inch] large-diameter zone-melt Si monocrystal ingots weighing between 7.5 and 8.4 kilograms. In order to fulfil a 1990-assigned Torch Plan project in the 3-inch technology for power electronics purposes, institute researchers in 1991 imported from Denmark a (Tuo-pu-suo) FZ-14-1 oven and a National TDL-FZ35 oven. To date, the institute has manufactured over 1 ton of the 3-inch zone-melt Si monocrystal, including over 20,000 wafers supplied to Wuxi Plant 742 and the Jilin Semiconductor Devices Plant for high-reverse-voltage transistors used in color TV production.

High-Strength Yttrium-Magnesium Alloys Developed

92P60341B Beijing ZHONGGUO KEXUE BAO [CHINESE SCIENCE NEWS] in Chinese 5 Jun 92 p 2

[Article by Xiong Hesheng [3574 0735 3932]: "High-Strength Yttrium-Magnesium Alloys Unveiled"]

[Summary] Guizhou [ZHONGGUO KEXUE BAO staff)—The MB25 and MB26 high-strength yttrium-magnesium alloys jointly developed by researchers at the Guizhou Science Institute and the Beijing Institute of Aeronautical Materials are ideal for enhancing the strength and reducing the weight of control arms for aircraft elevators and rudders. These two MB-series alloys are now being incorporated at the Nanchang Aircraft Manufacturing Co. and the Xian Aircraft Industrial Co. in making elevator control arms and rudder control arms for the Qiang-5 and Yun-7 aircraft, and have resulted in weight reductions of as much as 35 percent in the relevant aircraft parts.

China Marketing Computer-Aided Drug Design System

92P60337A Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 18, 6 May 92 p 1

[Article by Ke Wen [2688 2429]]

[Summary] China is marketing a computer-aided drug design (CADD) system (version 2.0) developed by the Shanghai Zhongli [0022 4539] Computer Co., Ltd. The system provides universities, research institutes, and pharmaceutical plants with a new tool for effective synthesis of new drugs. The system constitutes five subsystems—graphic data display, data prediction, data analysis, data base, and parameter operation—and contains 12 functional modules, for molecular plotting, chemical pattern recognition, quantitative structure-activity relation, quantum chemistry computing library, molecular electrostatic computation and presentation, computation of molecular mechanics, surface-accessibility calculation of molecules, molecular shape analysis, radicals data base, protein hydrogenation, partial charge programming, molecular coordinate-determination programming, and prediction. Of these 12 modules, the predictive and data base modules, the system's core, are the most creative ones. Price of the software developed for this system is about one-fifth to one-tenth that of the foreign-made software, and it has 10 more functions. The software can be used on IBM PC/XT, 386, and 486 microcomputers along with a normal black and white printer, color printer and color plotter. Because China is going to become a signatory of international drug intellectual property rights in 1993, it urgently needs to develop its own patented CADD system.

Genetically Engineered Viral Protein Gene Synthesized

92P60337C Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 22 May 92 p 1

[Article by Hu Zuo [5170 1563]]

[Summary] A genetically engineered coating protein gene of a Chinese strain of potato leaf roll virus has been synthesized by a research group led by Professor Zhang Heling [1728 7728 7881] of the Inner Mongolia University, and has been verified by the Beijing Agricultural University using fluorescence sequence analyzer. The group has been conducting the project under the National Natural Sciences Foundation of China since 1990. They purified the virus and its nucleic acid in 1991 and then synthesized and cloned the Chinese strain potato leaf roll virus, which is composed of 627 base-pair genes. The researchers are currently using the synthesized coating protein gene to culture leaf roll virus-resistant potatoes.

AIDS Drug Development Center Established in Lianyungang

92P60337D Nanjiang JIANGSU KEJI BAO in Chinese 3 May 92 p 4

[Article by Liu Bo [0491 3134] and Chen Jianjun [7115 1696 6511]]

[Summary] The first AIDS Drug Development Center for developing drugs for the treatment of AIDS has been jointly established in Lianyungang [Jiangsu Province] by the Basic Theory Department of the Institute of Traditional Chinese Medicine and the Lianyungang Dongfeng Pharmaceutical Plant. The center is planning to put out a new AIDS drug "keaike" [0344 5337 0668] in June 1992, and two other new drugs by the end of 1992 and in June 1993 respectively.

Expression of a Foreign Gene by Baculovirus With a Marker Gene

40091016A Shanghai SHENGWUHUAXUE YU SHENGWUWULI XUEBAO [ACTA BIOCHIMICA ET BIOPHYSICA SINICA] in Chinese Vol 24 No 2, Mar 92 pp 185-188

[English abstract of article by Chu Ruiyin [0328 3843 6892] (present address: National laboratory of protein engineering and plant genetic engineering, Peking University, Beijing 100871) and Wu Xiangfu [0702 6116 3940] of the Shanghai Institute of Biochemistry, Academia Sinica, 200031]

[Text] A recombinant plasmid pUATLHc containing two promoters of AcNPV polyhedrin gene was constructed. One of the promoter controls fused TGF-α/β-gel gene as a selection marker, and another controls hepatitis B virus core antigen gene. *Spodoptera frugiperda* cells were cotransfected with the plasmid DNA and wild type AcNPV DNA. It is very easy to select the recombinant virus through blue plaque. Plaque hybridization revealed all blue plaques contained the HBV core antigen genes. The expression level of HBc Ag in Sf cells infected with recombinant virus was determined.

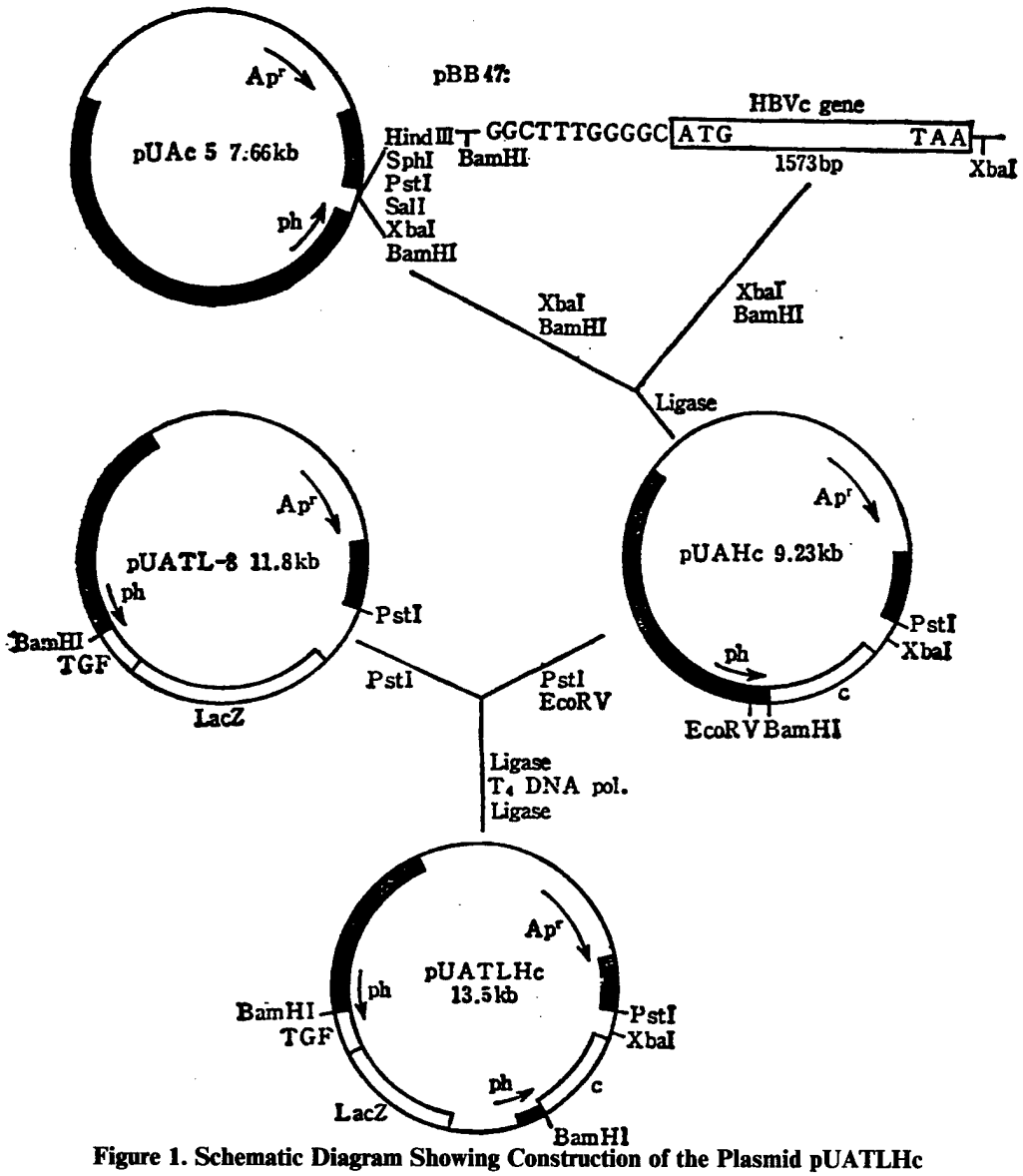


Figure 1. Schematic Diagram Showing Construction of the Plasmid pUATLHc

Localization of the Antigen in Erythrocytic Stages of Plasmodium Yoelii by Immuno-Electron Microscopy

40091016C Shanghai ZHONGGUO JISHENGCHONGXUE YU JISHENGCHONGBING ZAZHI [CHINESE JOURNAL OF PARASITOLOGY AND PARASITIC DISEASES] in Chinese Vol 10 No 1, Feb 92 pp 30-32

[English abstract of article by Wu Liju [0702 5461 5468], Zhu Ziyang [2612 3320 2799], and Pan Yurong [3382 3768 5554] of the Institute of Parasitic Diseases, Chinese Academy of Preventive Medicine (WHO Collaborating Centre for Malaria, Schistosomiasis and Filariasis), Shanghai, Liu Erxiang [0491 1422 5046] and Li Wenlu [2621 2429 8692] of the Institute of Basic Medical Sciences, CAMS (WHO Collaborating Centre for Research and Training of Immunology), Beijing. This investigation (880153) received financial support from the UNDP/WORLD BANK/WHO Special Programme for Research and Training in Tropical Diseases.]

[Text] In this study, the antigen recognized by the protective McAb M26-32 in erythrocytic stages of *P. yoelii* was localized by immuno-electron microscopy with LR White resin embedding and colloidal gold probe cytochemical techniques. The results indicated that the antigen which reacts specifically to McAb M26-32 was mainly localized within the cytoplasm of early and late

trophozoites, schizonts and merozoites, being the common antigen of asexual blood stages of the plasmodium. The amount of the antigen was on the increase during the development of trophozoite, while a portion of the antigen might be transported outward by exocytosis of the parasites and then be localized in the cytoplasm of the infected erythrocytes adjacent to the parasites.

Key words: *P. yoelii*, antigen localization, monoclonal antibody, colloidal gold labeling, immuno-electron microscopy.

Roles of T Cell Subsets in the Protective Immunity of Mice Against Plasmodium Yoelii

40091016D Shanghai ZHONGGUO JISHENGCHONGXUE YU JISHENGCHONGBING ZAZHI [CHINESE JOURNAL OF PARASITOLOGY AND PARASITIC DISEASES] in Chinese Vol 10 No 1, Feb 92 pp 33-36

[English abstract of article by Mao Yinghong [3029 2503 4767], Fan Rugong [2868 3067 1872], and Liu Erxiang [0491 1422 5046] of the Institute of Basic Medical Sciences, CAMS, Beijing, Su Wei [5685 5898] and Zhao Zishan [6392 1311 1194] of the Institute of Medical Experimental Animals, CAMS, Beijing. This project was supported by the National Natural Science Foundation of China.]

[Text] BALB/c mice which had developed protective immunity against *Plasmodium yoelii (P. y.)* challenge were injected with anti-CD4 or anti-CD8 monoclonal antibody, and were then challenged again with *P. yoelii*. No impairment of protection was observed. $CD8^+$T cells obtained from spleens of these mice were transferred to BALB/c nude mice and induced partial protection, while transfer of $CD4^+$T cells did not. In *P. yoelii*-mouse model, the parasites invaded reticulocytes in the early infection, and the infected reticulocytes could be recognized and attacked by sensitized $CD8^+$T cells. In late infection when *P. yoelii* also invaded mature erythrocytes, the protective effect of $CD8^+$T cells decreased and the main role of protection was played by antibodies.

Key words: T cell subsets, Plasmodium yoelii, protective immunity.

In Vitro Development of Sodium Artesunate Resistance in Plasmodium Falciparum

40091016E Shanghai ZHONGGUO JISHENGCHONGXUE YU JISHENGCHONGBING ZAZHI [CHINESE JOURNAL OF PARASITOLOGY AND PARASITIC DISEASES] in Chinese Vol 10 No 1, Feb 92 pp 37-39

[English abstract of article by Jiang Gangfeng [3068 6921 6912] of the Department of Parasitology, Guangdong Medical and Pharmaceutical College, Guangzhou 510224]

[Text] *Plasmodium falciparum* (Lab. culture FCR3 isolate) developed resistance to sodium artesunate after exposure to the drug *in vitro*. The drug effective concentration which resulted in 50 per cent schizont maturation inhibition (IC_{50}) was 1.6 ng/ml (4.1 nmol/L) before exposure to the drug. After 130 days of discontinuous exposure to sodium artesunate in a stepwise fashion, the sensitivity of the isolate to the drug decreased, with its IC_{50} 3-fold higher than that of the parent isolate. The resistance to artesunate decreased significantly after the resistant line was grown in drug-free medium.

Key words: *Plasmodium falciparum*, antimalarials, artesunate, drug resistance.

The Electronic Structure and Structure-Activity Relationship of Ericaceous Toxins

40091016B Shanghai HUAXUE XUEBAO [ACTA CHIMICA SINICA] in Chinese Vol 50 No 3, Mar 92 pp 237-243

[English abstract of article by Chen Changying [7115 1603 5391], Liu Zhuguo [0491 0504 0948], et al. of the Institute of Pharmaceutical Chemistry, People's Liberation Army, Beijing]

[Text] The quantum chemical (INDO) calculations have been undertaken for nine compounds extracted and separated from ericaceae plants. Various quantum chemical indices were obtained. Molecular electrostatic potential of some active site of these compounds was calculated and electrostatic potential contour maps were obtained. Lastly, we made a comparison by technology of molecular graphics for the space structure of these compounds and some alkaloids that the pharmacological nature are the same as ericaceous toxins. The feature of electronic structure, active site, acting mechanism and relationship between the electronic structure and the toxicity of these compounds were discussed and reasons for the difference of toxicity were explained on the basis of these results.

Ericaceous toxin is a cardioneurotoxin and is a very specific nerve cell membrane toxin. Its pharmacological activity is similar to aconitine, BTX-B, and veratriding. Compound 1 (Rhodoanthin) is the most poisonous among the nine compounds isolated.

Table 1. Structure and biological activity of compound 1-9

Compound Number	Compound Name	R^1	R^2	R^3	R^4	R^5	R^6	LD_{50} (μmol. kg^{-1})
1	Rhodoanthin	OH	CH_3	\O/		OH	OCOCH(OH)CH_3	0.10
2	Asebotoxin III	CH_3	OH	\O/		OH	OCOCH(OH)CH_3	0.20
3	Rhodojaponin III	CH_3	OH	\O/		OH	OH	1.10
4	Rhodojaponin V	CH_3	OH	\O/		OH	$OCOCH_3$	1.80
5	Grayanotoxin III	CH_3	OH	H	OH	OH	OH	2.30
6	Rhodojaponin II	CH_3	OH	\O/		$OCOCH_3$	OH	45.10
7	Rhodomollein I	$-CH_2$		OH	OH	OH	OH	71.90
8	Grayanotoxin II	$-CH_2$		H	OH	OH	OH	74.00
9	Rhodomollein III	CH_3	OH	OH	OH	$OCOCH_3$	OH	185.30

LD_{50}: half-lethal dose of tested mice

Status of Biological Industries

92FE0445 Beijing ZHONGGUO KEXUE BAO [CHINESE SCIENCE NEWS] in Chinese 28 Feb 92 p 4

[Article by Zhang Qixian [1728 0796 0341]: "The Current Situation and Development of China's Biological Industries"]

[Text] So-called biological industries are industries that utilize the unique functions of organisms or certain materials produced by organisms to produce useful materials. Generally speaking, they are industries that utilize biotechnology on an industrial scale to produce useful materials. In the broader sense, the objects that are utilized or processed by biological industries include microorganism cells, plant cells, and animal cells. The fermentation industry, whose utilization objects are microorganism cells, is a biological industry in the narrow sense. Looking at the actual current development situation, China's biological industry can be divided into three levels. One is the traditional fermentation industry centered on brewing and making food products. It has a long history and solid foundation in China. The second is the new type of fermentation industry centered on metabolic controlled fermentation and secondary metabolic product accumulation that has developed since the 1950's and 1960's. Examples include the amino acid industry, zymin industry, antibiotics industry, microorganism polysaccharide industry, and so on. The third level is the production of genetic expression products, interferon, growth hormone, and other products since the 1980's in which genetic recombination technology has been the turning point. This is the so-called modern biological industry.

I. Characteristics of the Current Situation

The characteristics of China's biological industry development can be summarized in the following areas:

A. The traditional fermentation industry accounts for an extremely large proportion of biological industry as a whole

Statistics show that the value of output of the traditional fermentation industry accounts for 80 percent of biological industry as a whole and for more than 95 percent of the total number of its enterprises. Overall, technical qualities are rather poor and modes of production are relatively backward. With the exception of a small number of excellent and special products, most products are relatively low-grade ones.

B. A large variety of products and large output, production technology levels for most products lag far behind advanced international levels, the product mix is less than rational

It can be said that with the exception of genetic recombination products, China has all of the main products that biological industries in foreign countries can produce. Moreover, we hold a decisive position in output of main products and rank among the world's leaders in output of products like monosodium glutamate, antibiotics, hard liquor, zymin, and other products compared to gross output in Western countries. Our production technology levels, however, lag far behind. Fermentation levels for penicillin, for example, are only 60 percent of those in foreign countries and output levels of glutamic acid are 50 percent of those in foreign countries. It can be said that in new types of fermentation industry, with the exception of Vitamin C, production levels for none of our products are superior to advanced levels in foreign countries. At the same time, our product mix is not very rational, and this is most apparent in the antibiotics industry. The phenomenon of irrational product mixes also exists in the amino acid industry, zymin industry, and other industries.

C. Many small enterprises, broad distributions, weak technology development levels in the enterprises themselves, which lack the ability to digest and absorb new technology and new techniques

China has nearly 10,000 producing enterprises in the biological industry, ranging from large to small in size, and they are scattered throughout China's 30 provinces, municipalities, and autonomous regions. Only a very few of them have research and development organizations. Nearly all of the new technologies they have came from research units or were imported from foreign countries. Because of the technical gradient that exists between scientific research units and enterprises, it is hard for many very good technical achievements to produce results in plants, which has made it hard for the advanced technology imported from foreign countries to form the economic benefits it should in enterprises. This makes technical progress in enterprises difficult, it makes product updating and replacement difficult, and it makes product quality improvements difficult. This is one of the reasons that enterprises now find it hard to gain vitality.

D. There are clear boundaries between industries, biological industry has no desire to permeate other industries, nor does it want to participate in the needs of other industries, so each lives and dies alone

China's biological industries are mainly under the jurisdiction of the Ministry of Light Industry, Health Management Bureau, Ministry of Commerce, and other units, so industry management is just like a yamen [government office in feudal China] that unifies everything under heaven. Industry blockades and technological secrecy are relatively prevalent. This is not like Japan, where although technological secrecy exists, there are rather frequent technological exchanges among industries, technology crosses over industry lines, and technological permeation is quite active. This conforms to the law that biological industry is a comprehensive technological industry. For this reason, biological industry in foreign countries has formed a development trend in which the leading waves propel the following waves and one wave passes higher after another. In comparison, all of China's biological industry enterprises are engaged in struggling for themselves and probing their own industry.

E. Our modern biotechnology industry is still in the sprouting stage

To date, no products produced by genetic recombinant production have entered the market on an industrial scale. They lag substantially behind foreign countries in technical levels, safety monitoring, product standard recognition, and other areas.

II. Development Directions

The 1980's was the decade of surging development of the world's biological industry. In the biotechnology field in the 1990's China does not have a solid foundation like the United States, nor do we hold a vanguard status like Japan in the fermentation industry field. Facing the world situation and China's present situation, China's biological industry and biotechnology should undertake work in the following areas.

A. Use modern biochemical engineering technology to upgrade the traditional fermentation industry

Transform the relatively backward modes of production in certain industries, reduce consumption of raw materials and energy resources, stabilize product quality, open up new sources of raw materials. This is the level of the fermentation industry that has the heaviest tasks and greatest significance. For this reason, it accounts for the largest proportion of value of output and consumes the most grain among biological industries. Liquor fermentation alone consumes about 15 million tons of grain a year, which is equivalent to China's total grain imports each year.

B. In the future, the following areas should be the development focus for China's new type of fermentation industry

Apply genetic recombination technology, cell fusion technology, reactor technology, and other modern biotechnology measures in the new type of fermentation industry to raise overall fermentation levels in this industry.

Open up new product realms, readjust the industry's product mix, adapt to and meet the requirements of domestic and foreign markets. The more prominent industries at the present time are antibiotics, zymin, and amino acids. Because these three industries got started relatively early in China and have the best foundation, the phenomenon of an irrational product mix is also the most prominent. According to development trends in foreign countries, the antibiotics industry should make great efforts to develop B-lactam semi- synthetic antibiotics. The zymin industry should reinforce food product-grade zymin production and be concerned with matching up enzyme product varieties and forms and gradually increase the proportion of protease used in detergents. The amino acid industry should combine improvements in glutamic acid fermentation levels and reductions in all types of unit consumption with efforts to develop feed-grade lysine production as quickly as possible. In addition, it should be concerned with matching production of various amino acid varieties and put an end to the situation of relying entirely on imports for the amino acid raw materials used in medicine.

We should work to open up realms of applications for existing products as quickly as possible, be concerned with synchronous development of new product production technology and applications realms, and break down the present rigid product markets. For a long time, China's biotechnology R&D has usually been concerned only with production technology and has neglected development of product markets. The result is a very narrow range of product applications and old products

have persisted for decades. As soon as the wind blows, there are product overstocks. No one dares make inquiries about new products and they do not know where to use them or how to use them, which has severely affected the development of existing biological industry and the formation of new industries. China's biological industry has or is now experiencing this type of bitter lesson. B-dextrin, microorganism polypeptides, organic acids, certain zymins, and so on are examples.

Innovation of fermentation product post-extraction technology and equipment and developing new types of highly effective separation media are other urgent tasks for China's biological industry at the present time. They are related to the quality of biological products, unit consumption levels of raw and auxiliary materials, enterprise economic results, environmental protection, and many other areas. Many of our products have not yet attained "bumper crops". Added to the backward post-extraction technology and equipment, they cannot ensure "bumper crops". If this continues for long, how can we attained advanced international levels?

C. Accelerate the formation of China's modern biotechnology industry

At present, we should first of all use product varieties that have already been developed in China and where we can gradually expand production like hepatitis-B vaccine, interferon, human growth hormone, and other products to form industrialized production. Selectively import representative genetic recombination product production technology and gradually establish a foundation for China's modern biological industry. At the same time, organize forces to strengthen tracking of key technologies in the biotechnology realm with the objective of new types of biologically processed products, and begin making preparations to develop China's modern biological industry system.

D. Develop related support industries

Bioengineering is an applied science that is closely related to microbiology, genetics, molecular biology, cell biology, biochemistry, physics, chemistry, mathematics, and other basic disciplines. Its development also depends on the development of chemical engineering, microelectronics, computer science, materials science, fermentation engineering, and other applied sciences. Similarly, as a biotechnology industry, its development must be coordinated with support industries. This is especially true with the increasing technological intensity of the industry, when it becomes even more prominent.

I feel that the areas of the support system that we should strengthen and develop are: design and processing of bioreactors and the design and processing of various types of high efficiency, energy-saving bioreactors for cultivating microorganism cells, plant cells, and animal cells; development and production of new types of biological product separation and post-extraction equipment and highly efficient separation media, which is a weak link in China's biological industry at present; focus on development and production of testing instruments, monitoring and control devices, matching reagents, and various types of durable transducers to overcome the present situation of China's basic reliance on imports and provide guaranteed conditions for higher level development of China's biological industry.

More Parallel Processing Systems Certified

S10/2 Minisupercomputer

92P60350A Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 23, 10 Jun 92 p 1

[Article by Zhang Xiuying [1728 4423 5391]: "S10/2 Minisupercomputer System Passes Appraisal"]

[Summary] The S10/2 minisupercomputer, a tightly coupled symmetric multiprocessor parallel processing system developed by the Ministry of Aerospace Industry, passed expert appraisal on 26 May in Beijing. This major achievement in domestic development of parallel computing systems breaks through a foreign technology blockade and provides a major boost to the nation's R&D of real-time computer simulation in military science and the applied sciences.

Based on the S10 high-performance multiprocessor system and on a few other computer models, the S10/2 runs under a real-time UNIX operating environment. In addition to a general-purpose program design language, the system comes with independently designed languages—parallel C, parallel FORTRAN, and parallel ICSL-II simulation language—as well as with a parallel algorithm library and other software. The S10/2 includes a graphics-support hardware system; the graphics processors and the CPUs operate in parallel for high-speed simultaneous dynamic output of graphical results. The system comes with A/D and D/A converters and with a variety of D/D interfaces, including PIO, IEEE488, and RS232. In a single-user environment, real-time response time is 0.3 ms; average real-time response time in a multiuser environment is 2 ms; and real-time response time for the highest-priority user is 300 μs.

Parallel Graph Reduction Intelligent Workstation

92P60350B Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 23, 10 Jun 92 p 1

[Article by Yun Hai [0061 3189]: "New Breakthrough in Research on Artificial Intelligence Technology: Parallel Graph Reduction Intelligent Workstation Unveiled at Qinghua"; cf. early brief reports in JPRS-CST-92-012, 18 Jun 92 p 53]

[Summary] The "parallel graph reduction intelligent workstation" developed as a State 863 Plan priority project by researchers in Qinghua University's Computer Department passed the State Education Commission-organized expert technical appraisal held on 8 May in Beijing. The experts have judged this system's performance to be at the worldwide state-of-the-art when compared to comparable commercialized systems and scholarly research reports. The development of this workstation represents a major step forward for domestic parallel computing, AI technology, and AI computer research.

This system can support parallel computing and symbol computations. Specifically, this AI workstation supports the parallel logic program design language PARLOG and the functional program design language ML, and has a certain image processing capability as well. The workstation incorporates 16 to 32 Transputers in a parallel speed-up system whose topological structure can be varied and scale enlarged via software routines. When in the 16-processor configuration, the system's peak computing speed is 240 MIPS and 40 MFLOPS. Symbol computing speed using PARLOG programming and ML programming is 307K-792K reduction steps/second and 826K-2170K reduction steps/second, respectively.

World's First Multilayer-MIMD System

92P60356A Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 24, 17 Jun 92 p1

[Article by Chen Zhihong [7115 1807 7703]: "Wuhan University Solves Problem of 'Multilayer Distributed Parallel Processing System, Parallel Algorithms'"]

[Summary] The "WUDP91 Multilayer Distributed Parallel Processing System and Parallel Algorithms" jointly developed by researchers in the Computer Science and Mathematics Departments at Wuhan University passed the expert appraisal organized by MMEI's Institute of Electrical Science on 9 June. The experts have appraised the system as being at the leading edge among advanced international parallel processing systems, and two parallel algorithms as being at the worldwide state-of-the-art.

This project, assigned by the Institute of Electrical Science and funded by a grant from the NSFC, was under the overall guidance of Prof. Chen Shenmeng [7115 5450 5492], who was responsible for closely coordinating the work of the two departments. The project has realized the world's first multilayer-MIMD [multiple instruction stream/multiple data stream] computer system, or multilayer distributed parallel processing system, with a combination loosely coupled and tightly coupled structure. The system has a high throughput and utilization, comes with a convenient man-machine interface, and is expandable and fault-tolerant. The two world-class parallel algorithms, oriented toward real-time requirements, are a "production-library optimum decision" algorithm and a "linear quadratic optimum control" algorithm. It is understood that this system can be easily commercialized into a new high-tech product, with applications in communications, decision support, and control areas.

Object-Function-Type Intelligent Language System Unveiled in Xian

92P60342A Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 22, 3 Jun 92 p 1

[Unattributed article: "Object-Function-Type Intelligent Language XJD-CLOS System Unveiled in Xian"]

[Summary] The "object-function-type intelligent language XJD-CLOS system" developed as a State 863 High-Tech Plan project by scientists in the New Computer Laboratory of the Computer Department at Xian Jiaotong University passed the technical achievement appraisal assigned by the State Education Commission and held a few days ago in Xian. Developed over a 2-year period by a research team led by Prof. Zheng Shouqi [6774 1343 3217], this system runs on a Sun workstation with the Common LISP 3.0 AI programming language, and provides the user with an object-oriented program design tool that operates in both element-object and element-loop modes. It is predicted that this advanced intelligent software system, meeting the international state-of-the-art, will be widely disseminated following its commercialization.

HUASUN 4075 Workstation, Four Software Packages Unveiled

92P60351A Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 23, 10 Jun 92 p 2

[Article by Xuan Gang [1357 0474]: "New HUASUN Workstation Products Unveiled"; see JPRS-CST-92-004, 20 Feb 92 pp 18-26 for feature on previous HUASUN 4000-series workstations]

[Summary] At the recently concluded Second National Electronic Information Applications Exposition, MMEI's Institute 6 unveiled its new HUASUN [Huasheng 5478 0524] 4075 workstation and four new software packages. Developed in only a year's time as a State Eighth 5-Year Plan key project, the HUASUN 4075, which recently passed design finalization, is completely compatible with the (U.S. firm) Sun SPARCstation II workstation; operating speed is 28.5 MIPS and MTTF as determined by FCC B-level EM-compatibility testing is over 10,000 hours. This workstation is especially suited to CAD/CAM, industrial control, and commercial management applications.

Four new copyrighted software packages designed for the HUASUN 4075 include the general-purpose finite-element-analysis CAD software FSAP V1.0.1, the high-level Chinese language environment ANCLE V1.0 based on the X11R4 windows standard of the copyrighted (non-UNIX) X11R4 software product, the Chinese-language outer-contour curve matrix software HANDA V1.0, and the outer-contour curve matrix generation tool COFE V1.2.

Beijing Firm Develops 8-Port Hub for 10Base-T Network

92P60342B Beijing ZHONGGUO DIANZI BAO [CHINA ELECTRONICS NEWS] in Chinese 3 Jun 92 p 1

[Article by Li Qiongrui [2621 8825 3843]: "Yinghua Markets LAN Hub"]

[Summary] The Ministry of Chemical Industry's Beijing Yinghua [5391 5478] Electronic Technology Co. recently unveiled its "10Base-T ETH-8HUB," or 8-port hub for the popular 10Base-T computer network. Developed in only 5 months by Yinghua, this hub—or concentrator/expander—when inserted into a network permits one to convert a traditional Ethernet's bus topological structure into a star topological structure; a common twisted pair line (such as telephone line) can be used to transmit a 10 Mbps [i.e. the standard Ethernet transmission rate] signal. The 10Base-T ETH-8HUB, which conforms to the IEEE802.3 and ISO-8802/3 standards, on 23 May passed the technical appraisal organized by MMEI's Computer Dept. and by the Ministry of Chemical Industry's S&T Dept.

Complex Ray Analysis of Scattering From RAM-Coated Targets

92P60349A Beijing DIANZI KEXUE XUEKAN [JOURNAL OF ELECTRONICS] in Chinese Vol 14 No 3, May 92 pp 254-261

[Article by Ruan Yingzheng [7086 4481 6927] and Du Huiping [2629 1920 1627] of the Second Department, University of Electronic Science and Technology (UEST) of China, Chengdu 610054: "Complex Ray Analysis of Scattering From Targets Coated With Radar Absorbing Materials," supported by grants from State Education Commission Ph.D. fund and NSFC; MS received 25 Nov 90, revised 17 Sep 91]

[Abstract] Complex ray theory (CRT) can be extended from lossless media into lossy media, and complex ray analysis for lossy media can be effectively used to analyze scattering from objects coated with radar absorbing materials (RAM). Advantages of this method include ease of calculation, clearness of physical meaning, and wide applicability in military stealth/ counter-stealth technology and related areas. As an example, the radar cross section (RCS) of conducting RAM-coated flat metal plates is analyzed; results demonstrate that the theoretical predictions agree well with the experimental data. All six figures are reproduced below; there are no tables.

References

1. E. F. Knott et al., "Radar Cross Section—Estimation, Measurement, and Reduction," trans. Ruan Yingzheng et al., Electronics Industry Publ. House, Beijing, November 1988.

2. Xu Xiaowen, "Theoretical Study of Coated Target Scattering Characteristics and Measurement of Coated Target Models," Ph.D. Thesis, UEST of China, Chengdu, 1989.

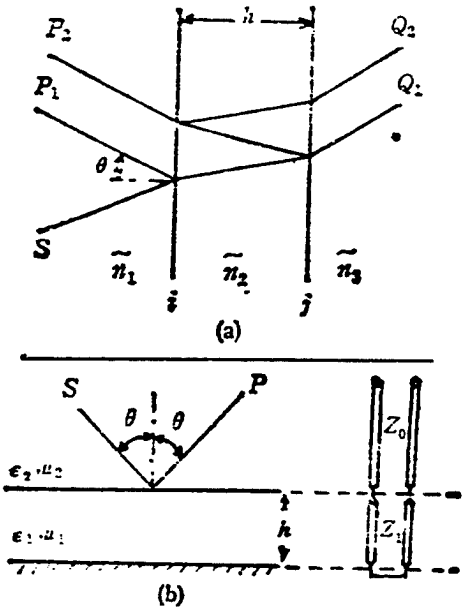


Figure 1. Two Analytical Models of Coated Metal Plate; (a) Laminated medium, (b) Equivalent transmission line

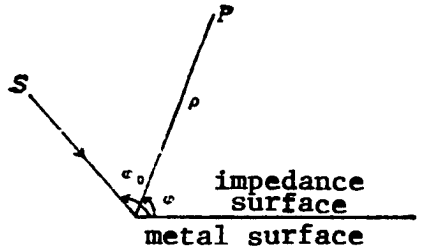


Figure 2. Geometrical Relationship of Scattering Field

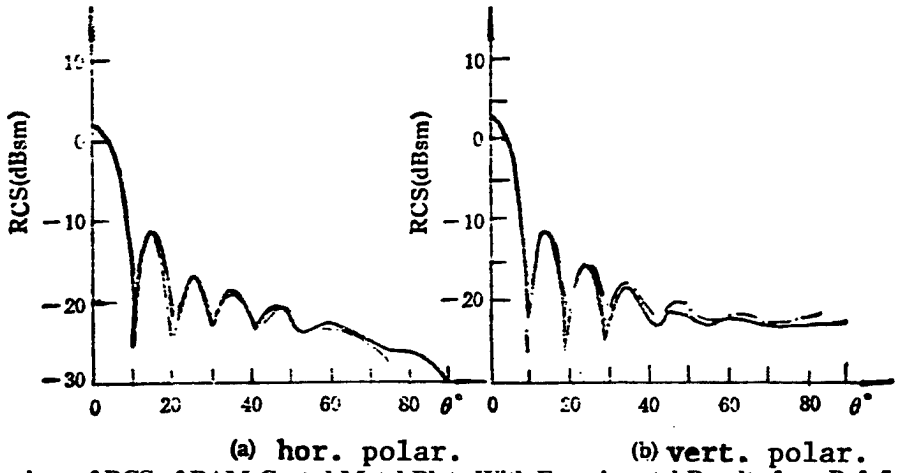
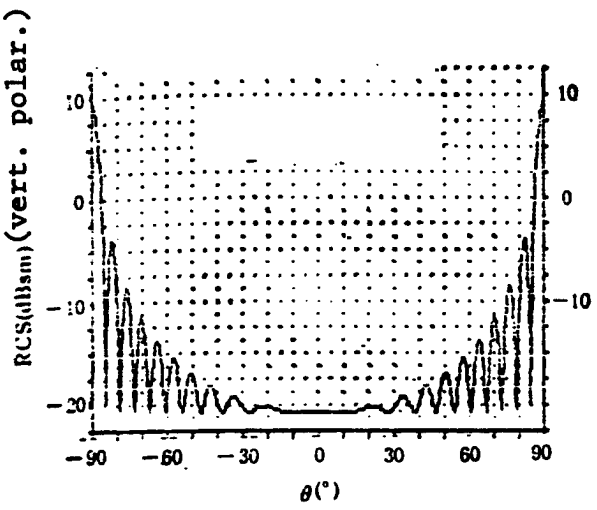
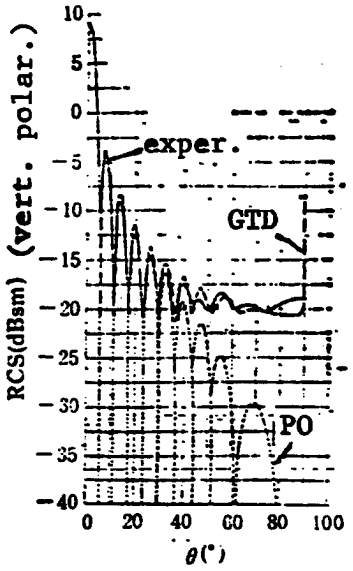


Figure 3. Comparison of RCS of RAM-Coated Metal Plate With Experimental Results from Ref. 5. Solid line—CRT calculated values, Broken line—Experimental results from Ref. 5; plate dimensions: 15 cm x 15 cm, f = 6 GHz, coating thickness h = 0.762 mm; coating material parameters: [tilde] = 1.47 = jO.853, [tilde] = 7.75 - jO.969



(a) CRT calculated results



(b) Experimental results and results calculated via other methods

Figure 4. Comparison of RCS of Uncoated Metal Plate With Experimental Results From Ref. 13. Plate dimensions: 16.5 cm x 16.5 cm, f = 9227.4 MHz, vertical polarization

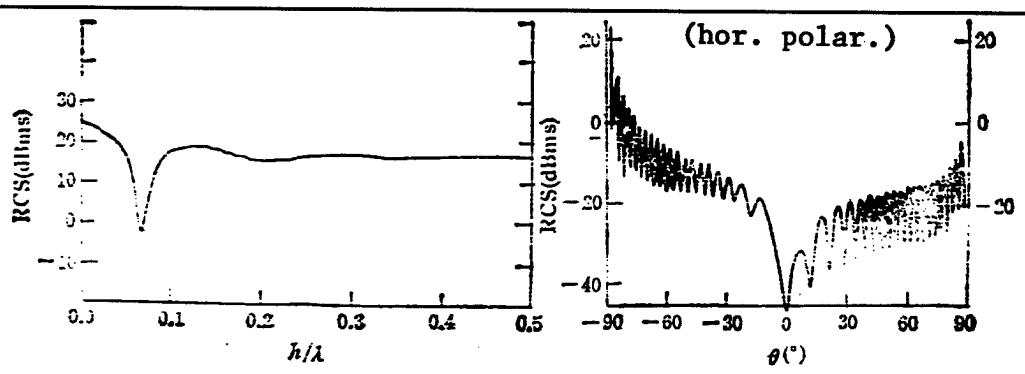


Figure 5. Influence of Coating Thickness on RCS Reduction; (a) Relationship between Max. RCS value of coated metal plate and coating thickness, (b) Comparison of metal plate RCS with two different coating thicknesses; 2a = 2b = 50 cm, h = 3.5 mm, [tilde] = 1.47 - jO.853, [tilde] = 7.75 - j0.969, f = 6 GHz

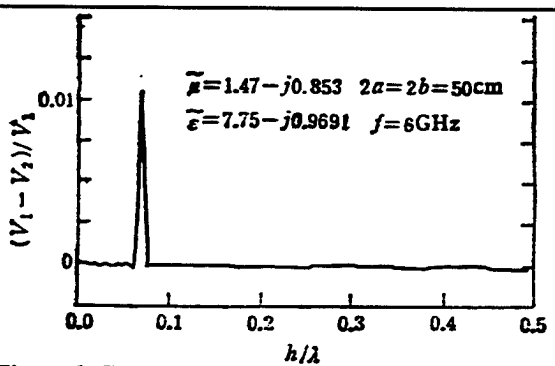


Figure 6. Comparison of Numerical Analytical Results of Two Models; V_1 = max. RCS value calculated for laminated medium model, V_2 = max. RCS value calculated for equivalent transmission line model

3. H. Ling, R. C. Chou, and S. W. Lee, IEEE TRANS. ON AP, AP-37 (1989) 2, 194-205.

4. R. Mittra, ed., "Computer Techniques for Electromagnetics," Pergamon Press, New York (1973).

5. Ruan Chengli and Wang Bingzhong, "RCS Study of Partially Coated Wing Structures," "Treatise on Military Target Characteristics and Transmission Characteristics With Brief Compilation," 1989, Qingdao, pp 60-60 [as published].

6. Ruan Yingzheng, DIANZI XUEBAO [ACTA ELECTRONICA SINICA], 17 (1989) 3, 89-94.

7. M. Born and E. Wolf, "Principles of Optics," 6th ed., Pergamon Press, New York (1980).

8. Ruan Yingzheng, ed., "Basic Electromagnetic Ray Theory," Chengdu Institute of Radio Engineering Publ. House, Chengdu, April 1989.

9. Ruan Yingzheng and Du Huiping, YINGYONG KEXUE XUEBAO [JOURNAL OF APPLIED SCIENCE], 10 (1992) 2, 13-19.

10. Ruan Yingzheng and L. B. Felsen, YINGYONG KEXUE XUEBAO, 7 (1989) 2, 174-177.

11. Ruan Yingzheng, DIANZI KEXUE XUEKAN [JOURNAL OF ELECTRONICS], 11 (1989) 4, 368-377.

12. Feng Wenlan and Ruan Yingzheng, DIANZI KEXUE XUEKAN, 12 (1990) 6, 664-667.

13. R. A. Ross, IEEE TRANS. ON AP, AP-14 (1966) 3, 329-335.

14. Jia Baofu, "Strong Turbulence Theory and Its Applications in Stealth-Oriented Radar-Absorbing Materials Research," Ph.D. Thesis, UEST of China, Chengdu, 1989.

15. Ruan Yingzheng and Du Huiping, DIANZI KEJI DAXUE XUEBAO [JOURNAL OF UEST OF CHINA], 20 (1991) 4, 368-374.

System Compensation in Inverse Synthetic Aperture Radar

92P60349B Beijing DIANZI KEXUE XUEKAN [JOURNAL OF ELECTRONICS] in Chinese Vol 14 No 3, May 92 pp 320-324

[Article by Meng Xiande [1322 2099 1795], Cao Zhidao [2580 1807 6670], and Su Fulin [1372 1381 2651] of Harbin Institute of Technology, Harbin 150006: "System Compensation of Inverse Synthetic Aperture Radar"; MS received 28 Mar 91, revised 29 Dec 91]

[Abstract] A method of compensating for the amplitude-phase distortion in an inverse synthetic aperture radar (ISAR) system is described. This system compensation is separated into two parts: compensation before mixing and that after mixing. System schematics are shown in Figures 1-2 below. The experimental configuration in the microwave darkroom at the Ministry of Aerospace Industry's Institute 207 is shown in Figure 3 below, while results of measurements taken in the darkroom are shown in Figures 4-6 and Table 1 below.

Table 1. Sidelobe (dB)

Item	Without compensation	After using following position compensation		
Position		0°	45°	90°
0°	-25.478		-39.794	-38.691
45°	-25.272	-41.399		-35.930
90°	-24.774	-36.806	-39.201	

References

1. Zhang Dengbo, "Synthetic Aperture Radar," Science Publ. House, Beijing, 1989, Ch. 4.

2. Meng Xiande et al., "Analysis of STRETCH Signal Distortion in Inverse Synthetic Aperture Radar," HARBIN GONGYE DAXUE XUEBAO [JOURNAL OF HARBIN INSTITUTE OF TECHNOLOGY], 1991, No. 4, 58-61.

3. Ministry of Aerospace Industry Institute 207, Introduction to Laboratory for Radar Target Reduction, Internal Report, Beijing, 1989.

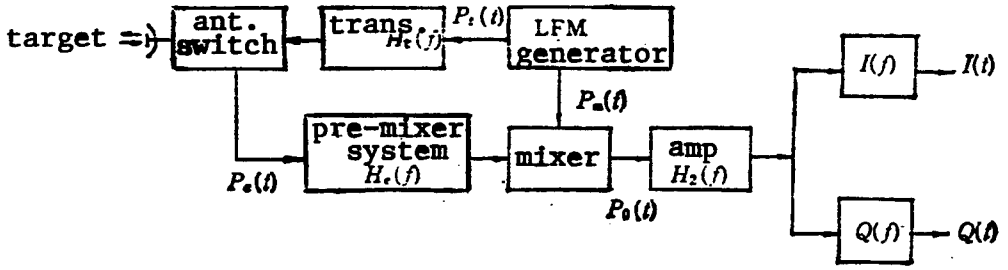


Figure 1. Schematic of ISAR Operating Principle
(LFM = linear frequency modulated signal)

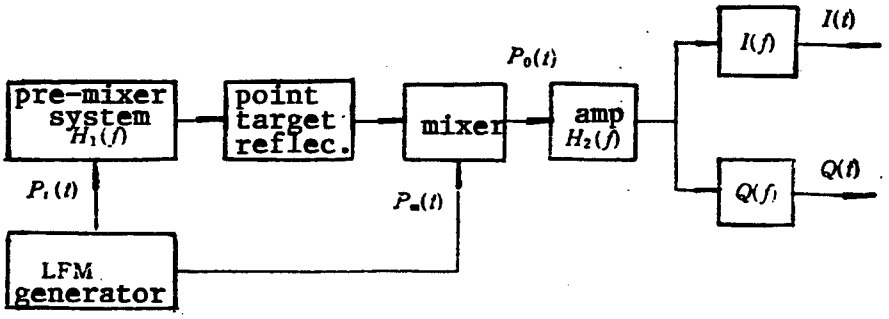


Figure 2. Simplified Schematic of ISAR System Compensation

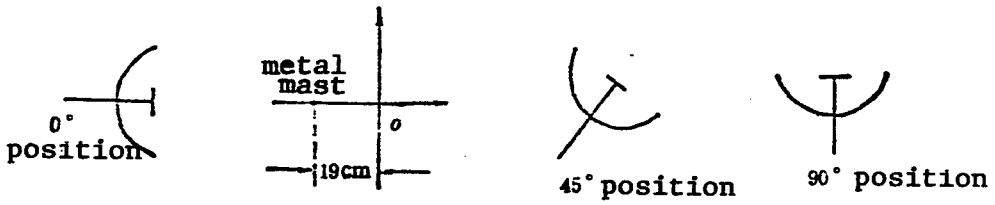


Figure 3. Microwave Darkroom Experiment With Metal-Mast Target (20 cm long, 0.5 cm in diameter)

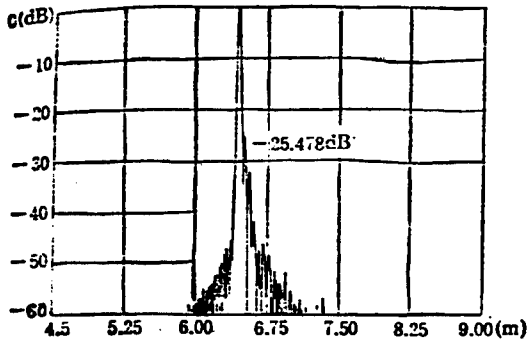


Figure 4. One-Dimensional Image of 0°-Position Target (Metal Mast)

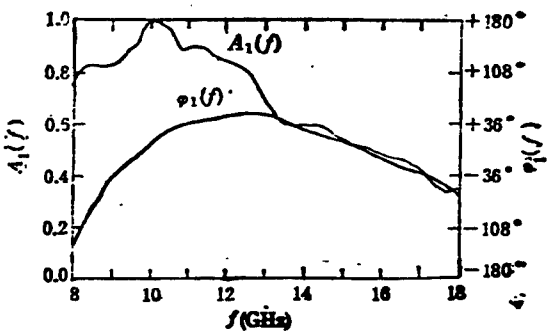


Figure 5. Measured System $A_1(f)$ and $\varphi_1(f)$ Using 0° Position

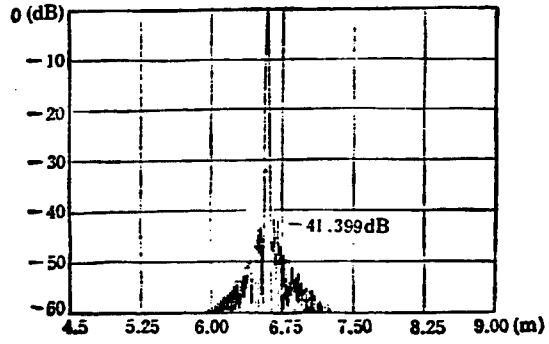


Figure 6. One-Dimensional Image of 45°-Position Point Target (Metal Mast) With 0° Position Compensation

Three-Layer Optical Neural Network for Rotation-Invariant Pattern Recognition

92FE0590A Shanghai HONGWAI YU HAOMIBO XUEBAO [JOURNAL OF INFRARED AND MILLIMETER WAVES] in Chinese Vol 11 No 1, Feb 92 pp 69-75

[Article by Gao Chengqun [7559 2052 5028], Huang Wuqun [7806 0063 5028], Shen Qinwan [3088 3830 1238], and Chen Tianlun [7115 1131 1510] of the Department of Physics, Nankai University, Tianjin, 300071, and Zhang Yanxin [1728 1693 3512] of the Institute of Modern Optics, Nankai University, Tianjin, 300071, supported by grant from NSFC: "Three-Layer Optical Neural Network for Pattern Recognition With Rotation Invariance"; MS received 28 Sep 90, revised 5 Mar 91. Cf. previous reporting on this topic in JPRS-CST-92-010, 22 May 92 pp 33-38]

[Text]

Abstract

A three-layer optical neural network model which has the capability of rotation-invariant pattern recognition for multiple targets is presented. This model has been used for the recognition of planar projections of four different types of aircraft. Computer simulations show that this model has good associative recognition capability for patterns inside and outside the training sets and for partially blocked patterns.

Introduction

The invariance property of pattern recognition refers to the ability of identifying a target when the target image undergoes a variety of changes. To recognize a complex target, even simple translation, rotation and scale changes would require very complicated computer calculations difficult to carry out in real time.

Optical pattern recognition is a topic that has attracted considerable attention because of the speed and parallel-processing mode of optical information processing. In recent years, a number of invariant optical pattern recognition techniques have been proposed,[1-5] of which the synthetic discriminant function (SDF) method is of particular interest. The basic approach of this method is to perform invariant coding of the different projections of a three-dimensional object, thereby greatly compressing the amount of information required. Since any projection of the same object has the same code, the problem of pattern recognition reduces to the much simpler problem of code recognition. An experimental implementation of the SDF technique has been reported in Ref. 6. Unfortunately, when noise is present or when the target is partially blocked, the recognition capability of this method is degraded, and decision errors frequently occur.

On the other hand, recent research in artificial neural networks has provided a new horizon for pattern recognition. Many neural network models proposed in the literature[7-10] all have fault-tolerance and noise-rejection capabilities; in particular, the Hopfield model has already been used in hardware implementation of optical vector-matrix multiplications.[11] However, this model does not have space-invariant properties and therefore cannot be used directly for pattern recognition.

In this paper, a three-layer optical neural network model which combines the SDF method and a neural network to provide not only rotational invariance but also fault-tolerant and noise-rejection capabilities is proposed.

1. Architecture and Main Features of the Model

Studies in visual psycho-physics have shown that the information processing of human vision is accomplished in layers.[12] Also, the theory of topology shows that the realization of spatial mapping (hetero-associative) using a neural network requires a network architecture of more than three layers: an input layer, an output layer, and at least one intermediate layer.[14] The three-layer neural network model proposed in this paper is shown in Figure 1. The image of the object is formed at the input layer to produce a distribution of the neural elements on the input layer (input pattern). the input layer and the intermediate layer form a hetero-associative (HA) storage device where invariant coding of the input pattern takes place; the cross-association is performed using an optical filtering technique derived from the SDF principle discussed earlier. The intermediate layer and the output layer form an auto-associative (AA) storage device which is based on the Hopfield model; the association is accomplished using an optical vector-matrix multiplication technique. The weights of cross-association are expressed in terms of the transmissivities of the optical templates at the corresponding positions.

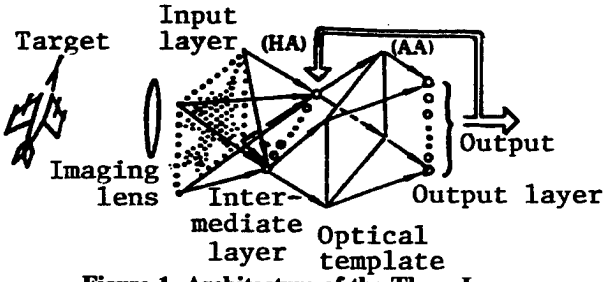


Figure 1. Architecture of the Three-Layer Neural Network

The difference between this model and the commonly used BP [back-propagation] model[8] is that the former is actually two neural networks connected in series. The weights of cross-association of the two networks can be individually designed (learned), but their performance complements each other. Its main advantage is that no complicated learning process is required, and the pitfalls of local minima which lead to unstable results can be avoided. More importantly, since the neural networks of the SDF model and the Hopfield model have already been realized using optical techniques, the current model which consists of the series implementation of the two models should be easy to realize using optical hardware.

2. Basic Principle

2.1 Synthetic Discriminant Function and Hetero-Associative Neural Network

It was pointed out earlier that invariant coding of the target projection is carried out in the first-stage HA network, and the weights of cross-association can be realized using N SDF filters.

Consider M different types of targets to be recognized; for each target, L different projection samples are taken. These samples are expressed in the form of a matrix which contains H (H is assumed to be 100 x 100 in this simulation) binary-valued neural elements (i.e., pixels) (Figure 2). Let it be denoted by $\xi(m,l) = [\xi_1(m,l), \xi_2(m,l), \ldots, \xi_H(m,l)]$, (m = 1, 2, ..., M; l = 1, 2, ..., L); each $\xi(m,l)$ can be regarded as an H-dimensional binary vector whose components $\xi_h(m,l)$ are either +1 (black spot) or -1 (white spot).

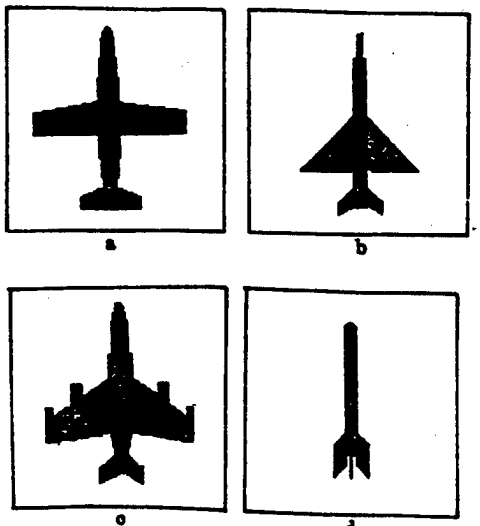


Figure 2. Unrotated Binary Projections of Four Targets To Be Recognized (100 x 100 Pixel Array)
(a) Airliner, (b) Fighter, (c) Bomber, (d) Rocket

The N SDFs are expressed in terms of an H-dimensional vector g(n), (n = 1, 2, ..., N) whose components $g_h(n)$, (h = 1, 2, ..., H) are in general not necessarily binary-valued. According to the SDF principle,[1] g(n) can be represented by a linear combination of $\xi(m,l)$:

$$g(n) = [g_1(n), g_2(n), \cdots, g_H(n)]$$

$$= \sum_{m=1}^{M} \sum_{l=1}^{L} a_{ml}^{(n)} \xi(m,l). \qquad (1)$$

The size of N is determined by the number of target types and the fault-tolerant ability of the second-stage neural network.

In order to achieve invariant encoding, it is required that the inner products of all projected sample vectors of the target ξ(m,l) (m fixed, l = 1, 2, ..., L) and the vector g(n) are constants, i.e.,

$$(\xi(m,l)\cdot g(n)) = C_{mn}, \quad m = 1, 2, \cdots, M; \quad n = 1, 2, \cdots, N. \qquad (2)$$

The constants C_{mn} depend only on the target and g(n), and are independent of l; therefore, C_{m1}, C_{m2}, ..., C_{mN} form a code set of the target m which does not change with the projection sample. In order to link with the next stage of the neural network, C_{mn} assumes the value +1 or -1, depending on the input state of the following stage.

To determine the coefficients $a^{(n)}_{ml}$ in equation (1), and hence the vector g(n), we form the inner product between ξ(m',l') and g(n) as follows:

$$(\xi(m',l')\cdot g(n)) = \sum_{m=1}^{M}\sum_{l=1}^{L} a^{(n)}_{ml}(\xi(m',l')\cdot\xi(m,l)) = C_{m'n} \quad (n = 1, 2, \cdots, N; \; m' = 1, 2, \cdots, M). \qquad (3)$$

where (ξ(m',l') x ξ(m,l)) is the inner product between the l'th projection vector of the m'th target and the lth projection vector of the mth target. Once the code is selected (as shown in Table 1), the linear equations (3) can be solved to obtain the expansion coefficients $a^{(n)}_{ml}$ of each cross-association matrix, from which the vectors g(n) of the N SDFs can be derived. By computing the inner product between any projection sample vector ξ(m,l) and g(n), one can obtain the characteristic code of the target C_{mn}, and use it for target recognition.

Table 1. Characteristic Code for Different Types of Targets

Target	Airliner	Fighter	Bomber	Rocket	Target	Airliner	Fighter	Bomber	Rocket
m	1	2	3	4	m	1	2	3	4
C_{m1}	-1	+1	+1	-1	C_{m9}	-1	-1	+1	-1
C_{m2}	-1	+1	-1	+1	C_{m10}	+1	-1	-1	-1
C_{m3}	+1	-1	+1	-1	C_{m11}	+1	+1	+1	-1
C_{m4}	+1	-1	-1	+1	C_{m12}	+1	-1	+1	+1
C_{m5}	+1	+1	-1	-1	C_{m13}	+1	+1	-1	+1
C_{m6}	-1	-1	+1	+1	C_{m14}	-1	+1	+1	+1
C_{m7}	-1	-1	-1	+1	C_{m15}	+1	+1	+1	+1
C_{m8}	-1	+1	-1	-1	C_{m16}	-1	-1	-1	-1

However, when noise is present or when the input projection is outside the sample set, the output code C'_{mn} (n = 1, 2, ..., N) from the HA network in general will be different from +/- 1. It is common practice to assign the value of C'_{mn} based on a threshold;[1] i.e., when C'_{mn} is greater than 0.5, it is assigned the value +1, and when C'_{mn} is less than -0.5, it is assigned the value -1; clearly, this process may produce decision errors. In order to improve the noise-rejection and fault-tolerant capabilities of the system and to reduce its decision error rate, we have developed a second-stage AA neural network by using the characteristic code C_{mn} as the stored pattern of the Hopfield model network. When the input code C'_{mn} reaches this stage of the neural network, the network will converge to the closest code C_{mn} through an iterative process.

2.2 Selection of the Target Code C_{mn}

In the discrete iterative Hopfield model, the elements of the cross-association matrix are:[13-15]

$$T_{ij} = \begin{cases} \frac{1}{N}\sum_{m=1}^{M} C_{mi}C_{mj}, & i \neq j; \\ 0, & i = j, \end{cases} \qquad (4)$$

where N is the number of neural elements, M is the number of stored patterns, $C_m = (C_{m1}, C_{m2}, ..., C_{mN})$ are the stored patterns, m = 1, 2, ..., M. The +1 or -1 value assigned to C_{mi} denotes the excited state or suppressed state of the neural element. If $C_{m'}$ is a particular stored pattern to be recognized, the neural element i is subject to a local field:

$$h_{m'i} = \sum_{j\neq i} T_{ij}C_{m'j} = \frac{1}{N}\sum_{j\neq i}\sum_{m=1}^{M} C_{mi}C_{mj}C_{m'j} \approx C_{m'i}(1+\delta_{m'i}), \qquad (5)$$

where

$$\delta_{m'i} = \frac{1}{N}\sum_{j\neq i}^{N}\sum_{m\neq m'}^{M} C_{mi}C_{mj}C_{m'i}C_{m'j}, \qquad (6)$$

The dynamic relation of the iterative process is:

$$C_{mi}(t + 1) = Sgn(h_{mi}(t)). \quad (7)$$

where t is the number of iterations, Sgn(x) is the signum function, and $\delta_{m'i}$ is a random variable with the following properties:

$$<\delta_{m'i}> = 0 \text{ and } <\delta^2_{m'i}> \approx M/N.$$

It is clear from equations (5) and (7) that when $\delta_{m'i}$ is greater than -1, $C_{m'i}$ has the same sign as $h_{m'i}$, and a correct decision will be made by the Hopfield network; otherwise the decision will be in error. Since $\delta_{m'i}$ is a random variable, an effective way to improve the performance of the neural network is to make all $\delta_{m'i}$ zero; this can be achieved by assigning orthogonal code for the four groups of C_{mn}, as shown in Table 1. If the values of Table 1 are substituted into equation (6), we obtain $\delta_{m'i} = 0$, which will clearly improve the pattern recognition capability of the network.

Selection of the code length N (i.e., the number of neural elements) has an effect on the fault-tolerant ability of the network; for a fixed number of targets, the larger M, N are, the better the fault-tolerant ability. Computer simulations show that[16] by using orthogonal code, when N = M/0.25, the network still has the ability to correctly recognize input patterns corrupted by 50 percent noise. In this paper, we choose M = 4, N = 16 to ensure that the system has strong fault-tolerant ability with the smallest number of SDF filters g(n).

3. Simulation Results and Discussion

In this paper, computer simulations of the three-layer optical neural network have been carried out to recognize the four types of aircraft shown in Figure 2 (airliner, fighter, bomber, and rocket). For each aircraft, 36 in-plane rotational projections are taken; each projection contains H = 100 x 100 = 10,000 pixels, and two adjacent projections are separated by 10°. The 144 two-dimensional projections of the four aircraft can be represented by:

$$\left.\begin{aligned}
&\xi(1, l_1) = (\xi_1(1, l_1), \xi_2(1, l_1), \cdots, \xi_N(1, l_1)), \quad (l_1 = 1, 2, \cdots, 36);\\
&\xi(2, l_2) = (\xi_1(2, l_2), \xi_2(2, l_2), \cdots, \xi_N(2, l_2)), \quad (l_2 = 1, 2, \cdots, 36);\\
&\xi(3, l_3) = (\xi_1(3, l_3), \xi_2(3, l_3), \cdots, \xi_N(3, l_3)), \quad (l_3 = 1, 2, \cdots, 36);\\
&\xi(4, l_4) = (\xi_1(4, l_4), \xi_2(4, l_4), \cdots, \xi_N(4, l_4)), \quad (l_4 = 1, 2, \cdots, 36).
\end{aligned}\right\} \quad (8)$$

By applying the method introduced in the previous section, we first determine the 16 SDFs g(n) corresponding to these targets and the elements T_{ij} from the specified C_{mn} code to construct the cross-association matrix of the three-layer neural network. Then we perform pattern recognition for the following cases: (1) one of the 144 sample patterns; (2) a non-sample pattern at an arbitrary in-plane orientation; (3) a partially blocked sample pattern. The method of recognition is to use one of the above patterns as the input state and perform computer simulations using equations (2) and (7). In general, convergence is obtained in less than three iterations of the second-stage neural network; the result would indicate that either one of the four types of aircraft is identified or none of them can be recognized. The time-consuming part of the computation is primarily in determining g(n), which corresponds to the programming process and learning process. If the number of target types M remains unchanged, this process needs to be performed only once. The actual target recognition takes very little time, which is desirable in practical applications.

The actual three-layer optical neural network will be realized using a hybrid electro-optical technique. Specifically, the input pattern is divided into 16 identical images using a two-dimensional raster; the images are processed by 16 pre-designed SDF filters to produce 16 inner products which are encoded to form the output pattern of the intermediate layer. This pattern is in turn used as the input pattern of the second-stage network for fault-tolerant processing and for identification of target type. Clearly, the actual system will use parallel operations which will speed up the recognition process considerably; this system is currently under development.

Computer simulation results show that:

(1) By using the 144 sample projections as the input pattern, the three-layer network is able to correctly identify the target type in all cases.

(2) By using a non-sample pattern at arbitrary planar orientation of the four aircraft (i.e., planar projections outside the 144 sample patterns) as the input pattern, the network is still able to identify the targets correctly. This verifies the in-plane rotation-invariant capability of the system.

(3) When the aircraft models are partially blocked with less than 30 percent blockage, there may be two-four errors in the output code of the intermediate layer, but the errors are corrected after fault-tolerant processing in the final layer of the network. The net result is that the system still accomplishes correct target recognition.

(4) Finally, when the input target is an object other than the four aircraft types, simulation results show that the three-layer network yields a code which is different from the sample code, and correctly points out that the target does not belong to any of the four aircraft types.

In summary, a three-layer optical neural network model which can be used for in-plane rotation-invariant pattern recognition with fault-tolerant capability against noise and partial blockage has been proposed. If two-dimensional projections with out-of-plane rotations are included in the stored patterns, then this model can be extended to provide spatial rotation-invariant pattern recognition of three-dimensional targets.

References

1. Casasent, D., APPL. OPT., 1984, 23(10): 1620.

2. Casasent, D., Liebowitz, S. A., APPL. OPT., 1987, 26(10): 1935.

3. Yin Shizhuo, Cheng Lu, Mu Guoguang, OPTIK, 1989, 82(4): 129.

4. Roeves, A. P. et al., IEEE TRANSACTIONS ON PATTERN ANALYSIS AND MACHINE INTELLIGENCE, 1988, 10(6), 937.

5. Schils, G. F., Sweeney, D. W., J. OPT. SOC. AM., 1988, A5(8): 1309.

6. Mu Guoguang, Cheng Lu, Yin Shizhuo, "Hybrid 3-D Target Recognition System Based on Serial-Code Filters." In PROC. OF ANNUAL MEETING OF OSA, Boston, 1990.

7. Hopfield, J. J., "Neural Networks and Physical System With Emergent Collective Computational Abilities." In PROC. NATL. ACAD. SCI. USA, 1982, 79(7): 2554.

8. Rumelhart, D. E., Hinton, G. E., Williams, R. J., "Learning Internal Representations by Error Propagation." In "Parallel Distributed Processing," D. E. Rumelhart and J. L. McClelland, Eds., MIT Press, Cambridge, 1986, Chap. 8.

9. Auderson, J. A. et al., PSYCHOL. REV., 1977, 84(5): 413.

10. Grossberg, S., NEURAL NETWORKS, 1988, 1(1): 17.

11. Farhat, N. H., Psattis, D., APPL. OPT., 1985, 24(10): 1469.

12. Triesman, A., SCI. AM., 1986, 255(5): 106.

13. Ying Xingren, PATTERN RECOGNITION AND ARTIFICIAL INTELLIGENCE, 1990, 3(1): 29.

14. Amit, D. J., Gutfreund, H., Sompolinsky, H., ANN. PHYS., 1987, 173(1): 30.

15. Little, W. A., Siiaw, G. L., MATH. BIOSCI., 1978, 39(3/4): 281.

16. Mu Guoguang and Zhang Yanxin, PATTERN RECOGNITION AND ARTIFICIAL INTELLIGENCE, 1990, 3(1): 53.

Optoelectronic Hybrid Implementation of Fuzzy Logic

92P60362 Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese Vol 19 No 4, Apr 92 pp 310-315

[Article by Liu Shutian [0491 2885 3944], Wu Jie [0702 2638], and Li Chunfei [2621 3196 7378] of the Department of Applied Physics, Harbin Institute of Technology, Harbin 150006: "Optoelectronic Hybrid Fuzzy Logic"; MS received 3 Jan 91, revised 8 Apr 91]

[Abstract] A simplified design for optical fuzzy logic gates consisting of optoelectronic hybrid circuits is presented. Four basic fuzzy logic functions—complement, maximum, minimum, and bounded difference —are demonstrated experimentally. A programmable multifunctional optoelectronic hybrid fuzzy logic gate is also proposed; different input assignments can be chosen by employing a multiplex logic circuit, and therefore seven basic fuzzy logic functions—the above four as well as bounded sum, bounded product, and implication—can be performed in real time. An eighth function, absolute difference, can be realized by using two bounded-difference gates. Figures 1-5 below show the circuit diagrams for the fuzzy complement and bounded-difference gate, the fuzzy minimum gate, the maximum gate, the absolute-difference gate, and the programmable multifunctional fuzzy logic gate, respectively. Table 1 below shows the input assignments of the programmable gate to achieve the seven different functions (in the table I_1 through I_6 refer to the six photodiodes in Figure 5).

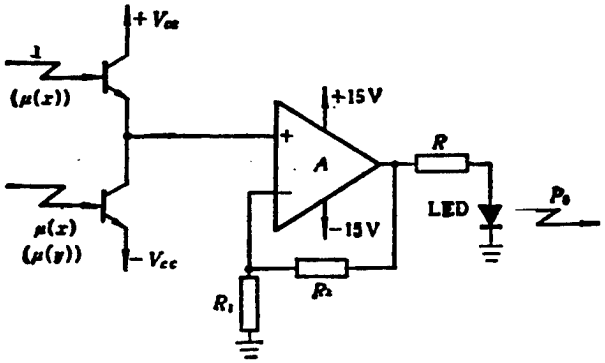


Figure 1. Circuit Diagram of the Fuzzy Complement and Bounded-Difference Gate

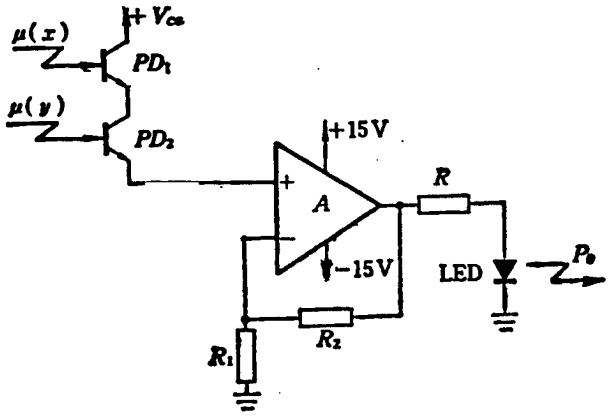


Figure 2. Circuit Diagram of the Fuzzy Minimum Gate

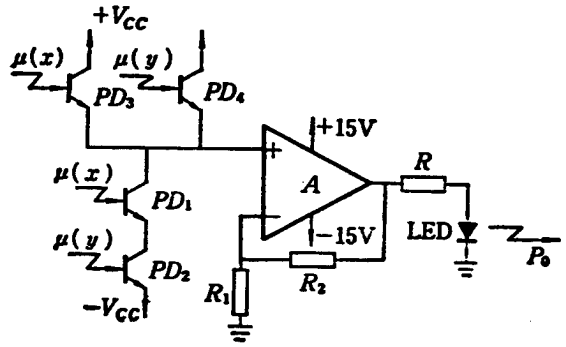


Figure 3. Circuit Diagram of the Maximum Gate

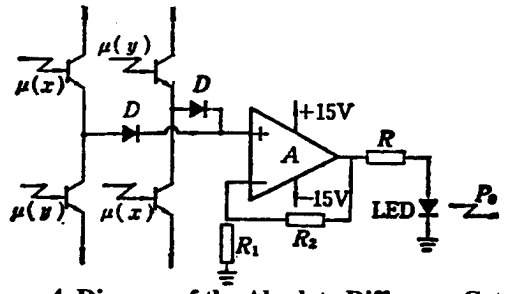


Figure 4. Diagram of the Absolute-Difference Gate Using Two Bounded-Difference Gates

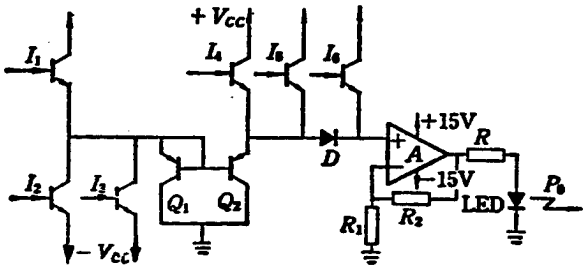


Figure 5. Circuit Diagram of the Programmable Multifunctional Fuzzy Logic Gate

Table 1. Input Assignment of the Multifunctional Programmable Fuzzy Logic Gate for Different Logic Functions

Name of the Function	I_1	I_2	I_3	I_4	I_5	I_6
Bounded-difference	μ(y)	—	—	—	μ(x)	—
Complement	μ(x)	—	—	—	1	—
Maximum	μ(y)	—	—	—	μ(x)	μ(y)
Minimum	μ(x)	μ(y)	—	—	μ(x)	—
Bounded-sum	1	μ(x)	μ(y)	—	1	—
Bounded-product	1	—	—	μ(x)	μ(y)	—
Implication	μ(x)	μ(y)	—	1	—	—

References

1. L. Liu, OPT. COMMUN., 73, 183 (1989).

2. H. Mada, in "Technical Digest of the 1990 International Topical Meeting on Optical Computing," paper 10 P4, Japan, 1990.

3. H.J. Caufield, APPL. OPT., 29, 2600 (1990).

4. S. Liu, J. Wu, and C. Li, OPT. LETT., 15, 691 (1990).

5. T. Yamakawa, et al., THE TRANSACTIONS OF THE IECE OF JAPAN, 64C, 147 (1981).

6. Liu Shutian, et al., ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS], 18, 691 (1991) [translated in full in JPRS-CST-92-002, 31 Jan 92 pp 39-45].

Free Electron Laser With Changeable-Period Wiggler

40100064 Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese Vol 19 No 4, Apr 92 pp 247-249

[English abstract of article by Lei Shizhan, Shanghai Institute of Optics and Fine Mechanics, CAS, Shanghai. MS received 18 Jul 90, revised 21 Aug 90]

[Text] The gain change of a free electron laser caused by the radiation frequency shift as the relativistic factor γ gradually decreases while the relativistic electrons propagate in the wiggler is analyzed. Using a wiggler whose spatial period changes along the propagation direction to keep the radiation frequency constant, one can increase the laser gain. The possible change law of spatial period is given.

Performance Analysis of Wideband Adaptive Interference Canceller Used in Towed Linear Array Sonar

92P60335A Beijing SHENGXUE XUEBAO [ACTA ACUSTICA SINICA] in Chinese Vol 17 No 3, May 92 pp 200-207

[Article by Yao Lan [1202 5663] and Cai Zhiming [5591 1807 2494] of the Harbin Shipbuilding Engineering Institute, Harbin 150001: "Performance Analysis of Adaptive Sidelobe Interference Canceller Used in Towed Linear Array Sonar;" MS received 22 Jun 91, revised 12 Sep 91]

[Abstract] In order to suppress strong interference at all bearing angles in a towed linear array sonar, an adaptive sidelobe interference canceller is commonly used, but this device's performance is limited when the strong interference is wideband and deviates greatly from the signal bearing. The limitation is due to the large fractional dispersion (FD), defined by the equation

$$FD = \Delta\tau \cdot BW = 1/2(N-1)(\sin\theta)(BW/f_0)$$

where $\Delta\tau$ is the time delay generated on the entire array surface by the interference, BW is bandwidth, N is the number of array elements, θ is the incident angle of the interference to the array normal direction, and f_0 is the wideband interference high-end frequency. In the present research project, a partially adaptive sidelobe canceller (PASC) with tapped delay-line (TDL) structure is developed and its performance in suppressing wide-angle wideband interference is analyzed. Results achieved via numerical methods indicate that a properly designed and constructed PASC has good cancelling performance (theoretical cancellation ratio of 17dB or more).

Figure 1 below shows the TDL structure, while Figure 2 shows the typical structure of the PASC; Figures 3-7 (not reproduced) depict various curves plotted from the performance data. One table shows three different configurations for the position of the auxiliary elements.

References

[1] W. D. White, "Wideband Interference Cancellation in Adaptive Sidelobe Cancellers," IEEE T. AES-19, No 6, Nov. 1983, 915-925.

[2] J. T. Mayhan, A. T. Simmons and C. C. Williams, "Cummings Adaptive Antenna Nulling Using Tapped Delay Line," IEEE T. AP-29, 1981, No 6, Nov., 923-936.

[3] R. T. Compton, "The Relationship Between Tapped Delay Line and FFT Processing in Adaptive Arrays," IEEE T. AP-36, No 1, Jan. 1988.

[4] Cai Zhiming, "Adaptive Sidelobe Interference Canceller Used for Towed Linear Array Sonar," Master's Thesis, Harbin Shipbuilding Engineering Institute, 1990, 69-74.

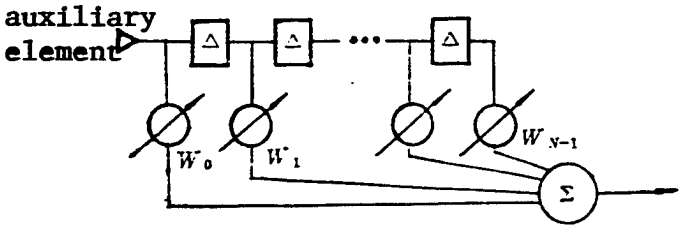


Figure 1 Structure of TDL as a Relative Dispersion Compensation Filter

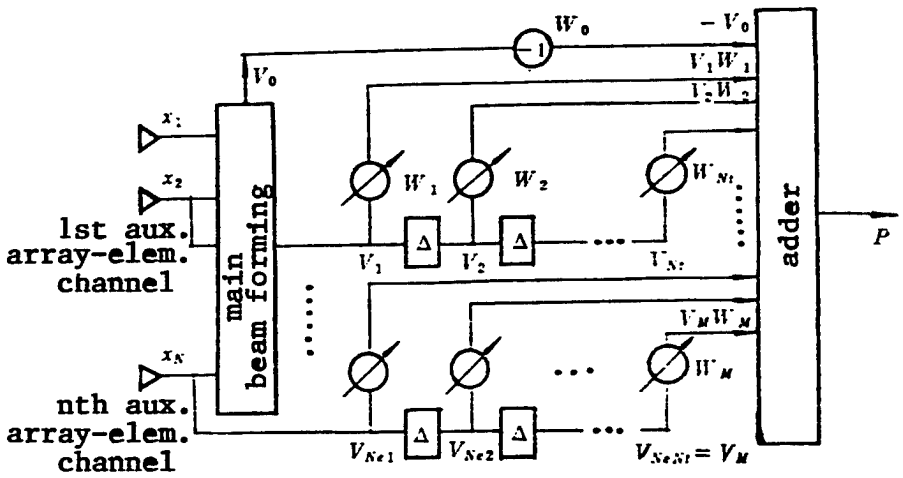


Figure 2 Typical Structure of PASC

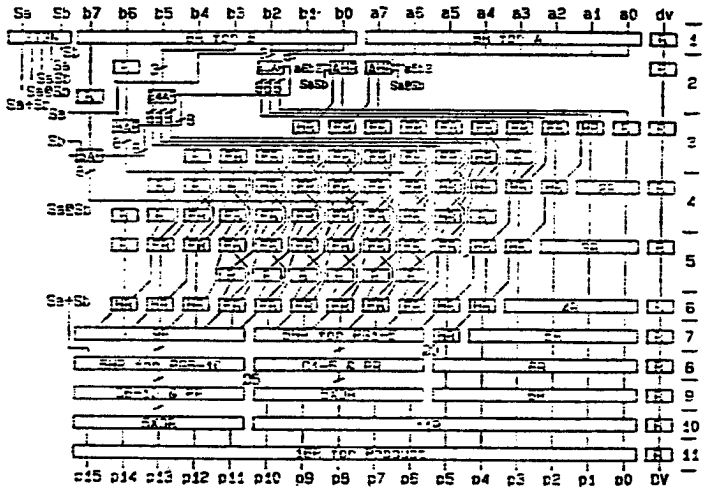


Figure 1 Schematic of Structure of 8 x 8-Bit Pipelined Multiplier

100MHz-Class Bit-Level Pipelined Multiplier Designed

92P60336A Beijing DIANZI XUEBAO [ACTA ELECTRONICA SINICA] in Chinese Vol 20 No 5, May 92 pp 39-46

[Article by Chen Hongyi [7115 1738 3015], Yue Zhenwu [1471 7201 0063], and Gu Qun [7357 5028] of the Microelectronics Institute, Qinghua University, Beijing 100084, "Systems Integration Technology" project supported by grant from NSFC: "Design of a Bit-Level Pipelined Multiplier;" MS received Mar 91, revised Sep 91]

[Abstract] An 8 x 8-bit pipelined multiplier fabricated with 2 μm N-well CMOS technology and containing only 2755 transistors (gates) is designed, an algorithm for both signed and unsigned multiplication is presented, and simulated performance results are given. The parallel semi-systolic-array architecture reduces the number of registers required, while latched domino circuits cut down the transistor count, increase speed (maximum pipelined operating frequency is 1000 MHz/8.4 = 119 MHz and time for one multiplication is 8.4 ns), and lowers power consumption.

Figure 1 below is a schematic of the 8 x 8-bit pipelined multiplier; in the figure, R is a register, AR is an AND gate with register for generating partial integrals, AHR is an AND half adder with register, HR is a half adder with register, FR is a full adder with register, SIGN indicates a combinatorial logic block generating control signals from S_a and S_b, and XOR is an exclusive OR gate with register. Five other figures (not reproduced) show schematics of the domino circuits, the FR circuit schematic and delay characteristics, schematics of the carry look-ahead generator circuit and its delay characteristics, schematics of other functional blocks in the multiplier, and schematics of the wait delay driver and clock tree system, respectively. Four tables list various parameters and comparisons of the multiplier and its subcircuits.

References: 8 English, 1 Chinese

CMOS ASICs for Video TFT-LCD Developed by Beijing University

92P60336B Beijing DIANZI XUEBAO [ACTA ELECTRONICA SINICA] in Chinese Vol 20 No 5, May 92 pp 74, 84

[Article by Guan Xudong [7070 2485 2639], Han Ruqi [7281 3067 3823] et al. of the Beijing University Microelectronics Institute, Beijing 100871: "CMOS Integrated Circuits for Video TFT-LCD;" MS received Sep 91]

[Abstract] In April 1991, the Beijing University Microelectronics Institute was the first domestic group to announce successful development of CMOS ASICs used to drive thin-film-transistor active-matrix liquid crystal video displays (video TFT-LCD). The two ASICs developed include the BDD1001 gate driver/sweep electrode bus drive circuit and the BDD2001 drain driver/signal electrode bus drive circuit, suitable for driving domestically made 200-line (specifically, 144 x 196-pixel amorphous-Si) video TFT-LCDs.

The master drawings and fabrication charts were prepared on a Compa-I CAD workstation, and are designed for 6 μm Si-gate P-well CMOS technology. The BDD1001 is a 28-pin IC, with 24 pins used for output; chip area is 3.15 mm x 1.56 mm. The BDD2001 is a 24-pin IC, with 14 pins used for output; chip area is 3.20 mm x 1.82 mm.

Novel Ku-Band LNA Made From HEMT, MMIC Presented

92P60336C Beijing DIANZI XUEBAO [ACTA ELECTRONICA SINICA] in Chinese Vol 20 No 5, May 92 pp 94-96

[Article by Dai Yongsheng [2071 3057 0524] of the Nanjing Electronic Devices Institute, Nanjing 210016: "Ku-Band LNA With HEMT and MMIC;" MS received Mar 91, revised Jul 91]

[Abstract] A novel Ku-band low-noise amplifier (LNA) consisting of a high electron mobility transistor (HEMT) and a monolithic microwave integrated circuit (MMIC) has been developed by the Nanjing Electron Devices Institute (NEDI). The amplifier's first stage incorporates feedback technology and the WC90 HEMT (also developed by NEDI), fabricated by MBE from AlGaAs/GaAs materials, to achieve simultaneous optimization of noise figure and gain. The WC90 chip has a notched dual-gate π structure, with an overall gate width of 200 μm and gate length of 0.3-0.4 μm. Additional parameters include: V_{DS} [drain-source voltage] = 2V, I_{DS} [drain-source current] = 8 mA, minimum noise figure = 1-1.2dB, and gain at 12 GHz operating frequency is about 7.5dB. The amplifier's second stage uses the NEDI-developed WD63 MMIC, which incorporates two-step hybrid microwave integration technology. The WD63 has post-encapsulated dimensions of 16 mm x 11 mm x 4 mm; the 3-stage amplifier chip itself has dimensions of 4.2 mm x 1.25 mm x 0.15 mm. The MESFET chip and the matched circuits are prepared on a semi-insulating GaAs substrate. Input and output is a 50-ohm microstrip interface, with the following typical performance characteristics: frequency range - 11.7-12.2 GHz, gain = 81-20dB, noise figure = 3.5-4dB, input/output voltage standing wave ratio (VSWR) <2. An SEM photograph of the MMIC interior is shown below in Figure 1.

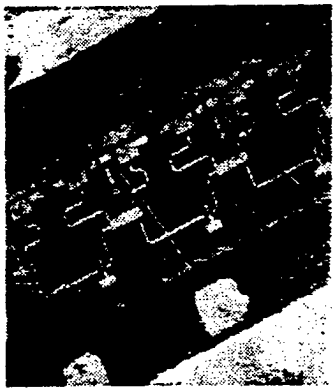


Figure 1: SEM Photograph of MMIC

The entire Ku-band LNA has a BJ-120 waveguide for its input/output. At an operating frequency of 11.7-12.2 GHz, this Ku-band LNA has demonstrated a noise figure of 1.9dB, a gain of 27 plus or minus 0.25dB, and an I/O VSWR under 1.4. The remaining figures—depicting the equivalent circuit of the LNA, a schematic of the LNA structure, and the principal electrical characteristics of the LNA, respectively—are shown below. This Ku-band LNA can be used in a Ku-band direct-broadcast satellite (DBS) TV receiver in place of a GaAs MESFET-based low-noise preamplifier to receive Japanese DBS TV programs.

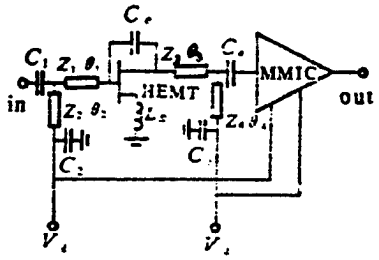


Figure 2. Equivalent Circuit of LNA

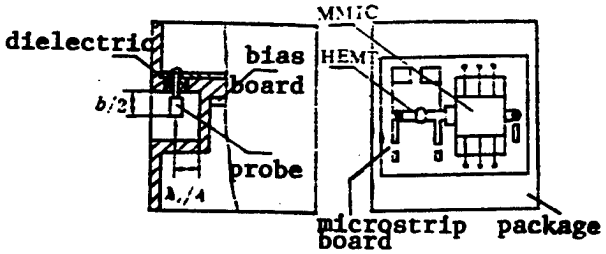


Figure 3. Schematic of LNA Structure

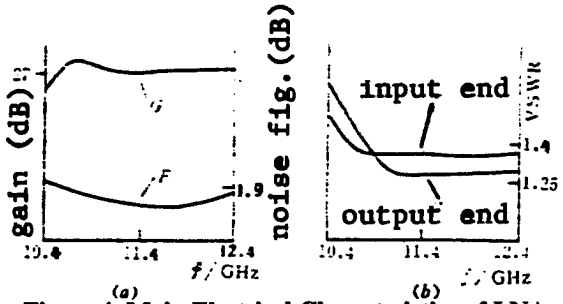


Figure 4. Main Electrical Characteristics of LNA

References: 9 English, 3 Chinese.

Properties of Epitaxial $YBa_2Cu_3O_7$ Thin Films Prepared by Pulsed Laser Ablation

40100063A Beijing DIWEN WULI XUEBAO [CHINESE JOURNAL OF LOW TEMPERATURE PHYSICS] in Chinese Vol 14 No 3, May 92 pp 167-174

[English abstract of article by Xiong Guangcheng, Lian Guijun, Li Jie, and Gan Zizhao of the Department of Physics, Beijing University, Beijing, 100871; MS received 21 Oct 91]

[Text] Epitaxial $YBa_2Cu_3O_7$ thin films were grown on $SrTiO_3$ (100) and Y-ZrO_2 (100) substrates by pulsed [excimer] laser deposition. A $T_c(R = 0) = 92.2K$ with a critical current density of 2.1 x 10^6 A/cm^2 at 77K was reached for a 2700 Angstrom thin film. The influences of substrate temperature on the superconductivity and the structure orientation for the $YBa_2Cu_3O_7$ thin films are studied.

References

1. A. Inam, M. S. Hegde, X. D. Wu, T. Venkatesan, P. England, P. F. Miceli, E. W. Chase, C. C. Chang, J. M. Terascon, J. B. Wachtman, APPL. PHYS. LETT., 53 (1988), 908.

2. B. Roas, L. Schultz, G. Endres, APPL. PHYS. LETT., 53 (1988), 1557.

3. J. Frohlingsdorf, W. Zander, B. Stritzker, R. Feile, P. Leiderer, PHYSICA, C159 (1989), 513.

4. J. Frohlingsdorf, W. Zander, B. Stritzker, J. OF LESS-COMMON METALS, 151 (1989), 407.

5. P. E. Dyer, A. Issa, P. H. Key, APPL. PHYS. LETT., 57 (1990), 186.

6. Testing Credentials, China Institute of Testing Technology, non-microcharacter # 91039, University of Electronic Science and Technology Appraisal Committee Document (1991).

Fabrication of Bi (2223)/Ag Tapes

40100063B Beijing DIWEN WULI XUEBAO [CHINESE JOURNAL OF LOW TEMPERATURE PHYSICS] in Chinese Vol 14 No 3, May 92 pp 180-186

[English abstract of article by Zhou Eyou, You Huiguo, Wu Meiying, Chen Hongbing, Wu Yixiong, and Hu Suhui of the Shanghai Institute of Metallurgy, CAS, Shanghai, 200050; MS received 16 Oct 91]

[Text] Single-core, 7-core, 49-core and 343-core multifilamentary Bi (2223)/Ag tapes were fabricated by powder-in-tube method. The effects of heat treatment, cold working and bending strain on superconducting properties and microstructure were investigated. It is shown that the sintering temperature is very sensitive to J_c of the tapes. The most effective sintering temperature is near 845°C. The intermediate pressing and sintering process is beneficial for improvement of J_c. The best J_c value has reached 1.5 x 10^4 A/cm^2 at 77K, 0T, and 1.2 x 10^3 A/cm^2 at 77K, 1T, for 49-core tape. When the core number increased, the strain-resistant property of tapes was also improved. The J_c of 343-core tape after a strain up to 1 percent proved to sustain about 70 percent of J_c with zero strain, which is five times that of single-core tape.

References

1. T. Hikaya et al., JPN. J. APPL. PHYS., 28 (1989), L82.

2. Zhang Jincang et al., CRYOGENICS, 30 (1990), 841.

3. W. Zhu et al., MATER. LETT., 9 (1989), 340.

4. S. Sato et al., IEEC TRANS. MAG., 27 (1991), 1231.

5. S. X. Don et al., SUPERCOND. SCI. TECH., 3 (1990), 138.

6. Y. Yamada et al., SUPERCOND. SCI. TECH., 4 (1991), 165.

7. Zhou Eyou et al., DIWEN WULI XUEBAO, 12 (1990), 417.

Thin-Film BiPbSrCaCuO DC SQUIDs operating at Liquid Nitrogen Temperature

40100063C Beijing DIWEN WULI XUEBAO [CHINESE JOURNAL OF LOW TEMPERATURE PHYSICS] in Chinese Vol 14 No 3, May 92 pp 236-240

[English abstract of article by Xu Hongda and Wang Hongjie of the Institute of Semiconductors, CAS, Beijing, 100083; Xue Shouqing of the National Institute of Metrology, Beijing, 100013; Shi Xianqing, Huang Xiaomei, Yang Caibing, and Cao Xiaoneng of the Institute of Electronics, CAS, Beijing, 100080; MS received 24 Apr 91]

[Text] DC-SQUIDs (direct-current Superconducting Quantum Interference Devices) have been successfully fabricated by using Pb-doped BiSrCaCuO superconducting thin films made by mixed evaporation of single source of resistance heating. The dc SQUID consists of a single round-washer with double bridge junctions. These SQUIDs show perfectly periodic voltage-flux characteristics. Without a magnetic shield, the typical flux noise and energy resolution in a frequency range from DC to 1 Hz at 78K are 1.7 x 10^{-3} φ_0/Hz$^{1/2}$ and 3.6 x 10^{-26} J/Hz, respectively. Meanwhile, it has been found that one of the SQUIDs operated in flux-locked mode showing voltage-flux second harmonic under no bias currents in the measuring circuit. This phenomenon is not clearly understood, but is related to I-V characteristics of the dc-SQUID and is discussed.

References

1. Y. Zhang, M. Diegel, and C. Heiden, IEEE TRANS. MAGN., 25 (1989), 869.

2. V. N. Polushkin and B. V. Vasiliev, MOD. PHYS. LETT., B3 (17) (1989), 1327.

3. S. Q. Xue, S. Z. Wang et al., CRYOGENICS, 30 (1990), 925.

4. K. P. Daly, W. D. Dozier et al., APPL. PHYS. LETT., 58 (1991), 543.

5. A. Z. Lin, H. Q. Li et al., IEEE TRANS. MAGN., MAG-25 (1989), 855.

6. R. Gross, P. Chandhari et al., APPL. PHYS. LETT., 57 (1990), 727.

7. V. Foglietti, R. H. Koch et al., APPL. PHYS. LETT., 54 (1989), 2259.

8. Huo Yuhua, Yan Shaolin et al., SOLID STATE COMM., 75 (1990), 991.

9. X. H. Zeng, S. G. Wang et al., CRYOGENICS, 30 (1990), 915.

10. Yi Zhang, Yunhui Xu et al., APPL. PHYS. LETT., 56 (1990), 1579.

11. I. S. Gergis, J. A. Titus et al., APPL. PHYS. LETT., 53 (1988), 2226.

12. D. W. Face, J. M. Graybeal et al., "High-T_c Update," 3, N. 15, August 1 (1989), 2.

13. Chen Lie, Zhao Zhihua et al., First National Symposium on SQUIDs and Their Applications, October 1990, Kunming.

15,000-Kilometer Fiber Optic Cable Trunkline To Be Built

92P60343A Beijing RENMIN RIBAO [PEOPLE'S DAILY OVERSEAS EDITION] in Chinese 10 Jun 92 p 1

[Article by Jing Xiaolin [2529 4562 2651]: "Large-Scale Fiber Optic Cable Trunkline Project Unfolding"]

[Summary] Beijing, 9 June (ZHONGGUO XINWEN SHE)—China has allocated investment funds for construction of a number of fiber optic cable communications trunkline projects. Construction of this 15,000-kilometer-long large-scale trunkline network, which will link up 21 provinces and municipalities, is now fully unfolding. The large-scale trunkline network consists of a Beijing-Shandong-Nanjing trunkline, a Zhengzhou-Xian-Chengdu trunkline, a Beijing-Wuhan-Guangzhou aerial trunkline, and a Beijing-Shenyang-Harbin trunkline. Contracts for provision of some of the fiber optic cable and equipment for these projects are being let to international bidding, while initial construction has already begun. The entire project is scheduled to be completed and operational within a few years. An MPT official revealed that when construction is completed, the nation's communications trunklines will have tripled, and long-distance transmission ability will have increased at least by a factor of ten.

Shanghai Ready To Boost Telecom Industry

40100065 Beijing CHINA DAILY (SHANGHAI FOCUS) in English 6 Jul 92 p I

[Article by staff reporter Chen Qide]

[Text] Shanghai is ready to rev up its communication industry in the coming years by cooperating with overseas investors.

"We should go ahead boldly with overseas cooperation. It is a shortcut to spur the local communication industry," said Wu Bangguo, Secretary of the Shanghai Communist Party Committee.

The official in charge of the target industry called at a recent mobilization meeting for the city to "devote its energies to several designated key projects."

The communication industry has been termed the city's No 2 backbone industry, following the vehicle industry.

As one of the country's three optical fibre communication bases (the others are in Xi'an and Wuhan), Shanghai has made great strides in that field in recent years.

Last year the city's output value in optical fibre communications reached 170 million yuan ($30.91 million), an increase of 70 percent over 1990. The figure is expected to jump to 300 million yuan ($54.55 million).

"However, it still lags far behind the general economic growth," said local sources.

The city is considering a local optical communication conglomerate and four joint ventures to catch up with the economy's pace, sources said.

The new ventures are designed to turn out optical cables, equipment for cable TV, optical and electrical terminals and other devices.

According to market forecasts, the country has the potential to use $80 million worth of optical terminals for optical cable TV in the next 5 years. So domestic demand would be for 24,000 optical and electrical terminals and 48,000 related devices.

On completion of those strategic moves, the city will be able to shape its scale of production to keep abreast with local economic development, they said.

By 1995, the city's sales volume of optical communication products can be expected to reach $140 million.